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Energy Issues in the Developing World

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and
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Lower oil prices are raising doubts about the underlying assumptions and ambitious energy programs of the last decade. How — and how hard — do countries pursue the goal of energy efficiency in an uncertain energy market?

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Policy, Planning, and Research

WORKING PAPERS

Energy Development

The developing world still needs large amounts of capital to meet its ever-expanding energy requirements. In most countries, these capital requirements are a big part of the total investment plan. The problems of debt and public revenues make the pursuit of efficiency as important a goal under declining fuel prices as it was under rising fuel prices. Other issues are less clear.

In an era of uncertainty, how do oil-importing countries decide whether to pass savings along to the consumer in lower oil prices or (considering the debt crisis) to treat them as windfall revenue gains? Reducing energy prices is relatively easy, but raising them has historically presented problems. What happens when international prices go up again?

What strategies should such non-OPEC oil-exporting countries as Malaysia, China, and

Mexico adopt to offset export losses?

How do developing countries decide whether to invest in further oil and gas exploration or in alternative fuels, and how much should the Bank support them? What should be done with white elephant projects?

How do governments arrive at a productive partnership between the public and private sectors?

What will happen in poorer developing countries that cannot bear the high capital costs of investing in fuel-switching capabilities yet otherwise remain vulnerable to sudden fluctuations in fuel prices?

How do decisionmakers assess the risks of energy investments in an uncertain energy market?

This paper, a product of the Energy Development Division, Industry and Energy Department, has also appeared as an Industry and Energy Department Working Paper. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Mary Fernandez, IENED Publications Manager, room S4-037, extension 33637.

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FOREWORD

1986 and 1987 were years of considerable confusion for those working in the energy field. The lower oil prices called into question many of the fundamental assumptions that were the stock in trade of energy experts during the previous ten years. In many developing countries, doubts began to arise about the ambitious energy programs and projects of the past decade.

The collection of papers in this volume represents responses to these concerns, prepared by current and former World Bank staff. They do not reflect any "official" position of the Bank, but rather are illustrative of the impact of the recent events on the thinking of some of our staff who continue to be active in the still ongoing debate over how to interpret energy related developments.

Although these papers were initially prepared for quite different audiences and raise a variety of different concerns, a common theme that runs throughout the volume is the need to continue the pursuit of efficiency goals in the energy sector. The developing world still needs large amounts of capital to meet its ever-expanding energy requirements. These capital requirements will be a significant part of most country's total investment plan. Given the problems of debt and public revenues, the pursuit of efficiency is just as important under lower fuel prices as it is under rising fuel prices.

These papers have been put together in one volume in order to facilitate access to some of the interesting and provocative ideas that deserve wider circulation. Only minor editing and selected updating have been done. As separate, self-contained presentations made on different occasions, there is inevitably some overlap, but this also helps provide continuity and consistency to the volume.

Anthony A. Churchill
Director, Industry and
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February 1988

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Lessons from Turmoil: A Developing Country Perspective

Robert J. Saunders

Introduction

In developing countries, the lower crude oil prices of the last two years have primarily affected government budgets and country balance of payments flows. The effect of lower oil prices has been mostly limited to country fiscal impacts for at least two reasons. First, there has not yet been enough time for many fundamental growth-inducing structural changes in consumption or investment to manifest themselves. Second, and perhaps more important, there is a question about how much of the decline in oil prices developing country governments initially passed through to final consumers.

The drop that took place in international crude oil prices in 1986 attracted worldwide comment and reactions ranging from relief by oil consumers to serious concern on the part of high-cost oil producers. However, the oil price changes have not affected most of the fundamental energy-related problems identified in developing countries during the 1970s and early 1980s. The demand for energy investment remains large, and oil imports (or exports) still represent a significant outlay (or source) of foreign exchange for most developing countries. In fact, the decline in oil prices and accompanying energy price-related uncertainties have created their own new set of problems for developing countries. As a result, energy sector investment programs must be reexamined. Fiscal regimes and policies need to be refocused. Options for increasing the flexibility of fuel switching and short-term interfuel substitution must be addressed. And, of course, the oil-exporting developing countries such as Mexico, Nigeria, Indonesia, and Egypt, faced with reduced foreign exchange earnings, must make difficult economic and financial choices.

In addition to short-term policy adjustments to lower oil prices, developing countries must also address fundamental longer term energy issues. These include massive financing requirements for energy investments, the diminished interest of commercial banks in industrial countries in financing energy investment in high debt developing countries, inadequate domestic resource mobilization, fuelwood shortages and deforestation, market imperfections in the production and allocation of energy resources, the

Note: The initial draft of this paper was presented at the conference "Energy 1986: Lessons From Turmoil" organized by The Royal Institute of International Affairs, The International Association of Energy Economists, and The British Institute of Energy Economics and held in London in December, 1986.

chronically poor performance of many energy sector enterprises, and the role of the private sector in financing and operating energy production and distribution activities.

Background

In considering the effects of lower oil prices in developing countries, it is important to note that these countries are a very heterogeneous group. Therefore, fluctuations in oil prices will have many different impacts, depending on the economic characteristics of the country--whether it is an oil importer or oil exporter, whether energy markets are allowed to function freely, and depending on the strength and composition of its economic base, its natural resource endowment, income level, human resource skill levels, etc.

Although developing countries account for a small share of the world's commercial energy consumption, this share is increasing. In fact, most experts agree that commercial energy demand in developing countries has tremendous growth potential. There is, however, great uncertainty in projecting the rate at which that potential will be realized. During the 1970s, the demand for commercial energy in developing countries grew an average of 6% a year, with oil consumption increasing at about the same rate. As a result, developing countries' share in total commercial energy consumption, as well as in total world oil consumption, increased from about 16% in 1973 to roughly 25% in 1985. Developing country growth in commercial energy consumption slowed during the 1979-83 period after the second oil price shock; at that time, the rate of growth in oil consumption was less than that for total commercial energy. During the last couple of years the lower growth rates have prevailed.

When world crude oil prices were increasing during the 1970s, most oil-importing developing countries realized the need to raise domestic petroleum product prices to international levels. This was usually palatable, first because the fiscal impact of subsidizing oil consumption was larger than most oil importing governments could absorb, and second, because it was recognized that subsidies would increase relative consumption and result in even higher financial subsidies. By the late 1970s and early 1980s, most oil-importing developing countries had adjusted to the new, higher petroleum price levels, although in many instances tight controls on domestic petroleum prices did not allow them to adjust quickly to short run fluctuations in price. There were, however, a few countries that did not adjust prices upward during this period--primarily net oil exporters. In the few developing countries that maintained low petroleum prices during the 1970s, demand grew at relatively higher rates and investment decisions tended to favor relatively energy-intensive activities and consumption patterns.

While many factors may be responsible for the different rates of economic growth in individual developing countries during the 1970s and early 1980s, the evidence on one point is fairly clear. Countries that fostered more market-oriented economies and increased petroleum prices to reflect international levels generally experienced relatively stronger economic

growth. On the other hand, oil importing countries in which the public sector dominated the economy and the government shielded consumers from balance of payments difficulties tended to experience relatively less buoyant economic activity.

Country Fiscal Impact

As noted above, the decline in crude oil prices that took place in early 1986 has primarily affected government budgets and country balance of payments flows. As a result of the almost halving of oil prices, from about US\$30/barrel to US\$15/barrel, the world economy is experiencing the equivalent of a relative transfer of revenues from oil exporters to oil importers. In this process, there are winners and there are losers.

To many oil-importing developing countries, the decline in oil prices is providing needed fiscal relief. For example, a drop in prices to US\$15/barrel could reduce the import bill in Korea by about 2.5% of GDP and in the Philippines and Thailand by just under 2%. Turkey, Thailand, Korea, Brazil, and India, as principal beneficiaries of an oil price fall, could save from 10 to 20% of their total annual import bills.

On the other hand, developing country members of OPEC, many of which rely on oil exports to provide anywhere between 50-90% of their revenues, have been adversely affected by lower oil prices, as well as by the recent fall in the value of the US dollar. Non-OPEC developing country exporters, such as Malaysia, China, and Mexico, also are experiencing serious export revenue losses. For example, if oil were selling at US\$15/barrel, Malaysia and China could lose about US\$1.6 billion and US\$2.5 billion respectively, each year in revenues. In GNP terms, this loss would amount to about 5% of GNP in Malaysia and less than 0.5% for China. However, for China, a price of US\$15/barrel for oil could bring about a 10% loss in total export earnings. In Malaysia, a price of US\$15/barrel for oil could imply a loss of about 20% in government revenue.

Of course, the decline in oil prices also conveys secondary effects which could benefit many developing countries. These effects, other things being equal, include reduced inflation and interest rates, and hence lower expenses for debt service.

Domestic Oil Pricing Policies

In the relatively small number of developing countries that have less regulated energy markets, the fall in world oil prices has been mostly passed on to final consumers. In some instances, this has resulted in selective fuel switching and other small increases in the demand for oil products. However, in the many developing countries where fuel prices and supplies are heavily regulated, or where there are other upstream market imperfections, the lower international oil prices have not completely filtered through to many of the downstream markets. For example, while the

Philippines and Malaysian governments have passed on part of the price decline to consumers, many other developing country governments initially kept petroleum prices constant or even tried to increase them (e.g., India). There are several reasons for not immediately passing through savings in oil price to final consumers.

- ° Governments may want to take advantage of the reduced price to capture additional government revenues;
- ° Governments may take a cautionary stance of not passing too much of the savings forward, against the likelihood that world oil prices will remain volatile and the possibility that prices might rebound significantly;
- ° There may be an adjustment lag in the many developing countries which have regulated responses to external market change, so prices do not adjust automatically; and,
- ° Any potential adjustments to be made must also reflect shifts in currency values.

The basic point is that sudden windfall revenue gains can give a country time for maneuvering. Energy policymakers in many oil-importing developing countries are still considering how the surplus revenues resulting from the lower oil import prices should be allocated between the government, consumers, and energy companies. To what degree should domestic retail prices follow the world market? Should prices be maintained at higher levels, allowing government to capture the margins for fiscal reasons? Should the incentives designed to encourage oil and gas exploration by international companies be maintained, improved or reduced? Should oil importers defer or revise some planned domestic energy investments? What should be the short-term strategy for improving energy conservation and efficiency?

A strict application of economic efficiency criteria would suggest that petroleum fuel prices be adjusted to reflect international market levels (border prices). Among other things, this would help export industries to remain competitive. On the other hand, there are a number of oil-importing developing countries where, because of large public sectors or balance of payment deficits, government fiscal issues tend to dominate. It is in these countries that the options for capturing rents and related issues must be given particular attention. Governments must carefully analyze methods for capturing the windfall oil revenues and attempt to choose the mix of energy taxation schemes that best accommodates the principles of efficiency and neutrality.

Apart from economic efficiency and fiscal criteria, policymakers of course also consider the political dimension of adjusting prices. While reducing energy prices in many developing countries is a relatively easy process, historically there have been political and social problems associated

with increasing energy prices. Finally, governments must also guard against the risk that energy efficiency and conservation programs may be deemphasized and that the prevailing reduced level of oil prices may detract attention from the longer term need for efficiency in use.

Longer Term Investment Impact

If changes in oil prices eventually are passed through to downstream markets, the energy consumption level and the mix of investment in all commercial and many non-commercial energy sources will be affected. One consequence of lower oil prices and the greater uncertainty and volatility in the international oil markets is that larger energy consumers will consider investing in more flexible plant and equipment to increase fuel switching capability. This has already happened in many industrialized countries, and the same process of fuel diversification and investment in fuel switching capacity is now expected to speed up in some of the middle-income developing countries.

Many of the poorer developing countries, however, cannot bear the higher capital cost of investments required to promote greater fuel flexibility. Therefore, they will be relatively more vulnerable to sudden fluctuations in future fuel prices.

In the petroleum sector, lower oil prices are forcing international oil companies (IOCs) and national oil companies (NOCs) to be more selective and to restrict discretionary outlays for oil and gas exploration and development. This even applies to developing countries that have relatively good prospects. In some cases, IOCs find that an investment in the production of hydrocarbon resources, while economically attractive for the developing country, is of low financial priority for the IOC.

If developing countries that have exploration potential wish to avoid a continued reduction in their exploration programs, many of them will have to adjust to the new situation by: (a) making more attractive areas available to IOCs; (b) negotiating more flexible exploration contracts that provide better returns to the IOCs during periods of low prices, but perhaps allow the country to recapture a larger share if prices rise; and (c) allowing IOCs to stretch out their work commitments and adopt a policy of stepwise decision making. Relatively high cost oil-producing countries might also consider postponing exploration and development for new oil fields on the grounds that volatile oil prices could, during the next few years, decrease as well as increase. The overall objective of developing countries in the petroleum sector should be to obtain the maximum present value of total revenues, not the maximum current royalty per unit of oil or gas.

Natural gas investments most likely to be affected by lower fuel oil prices are those which involve long distance pipelines and liquified natural gas, i.e., those projects which have high up-front fixed costs. In countries which have low cost gas supplies and relatively short distances from the gas field to the market, natural gas development for domestic use should, in most

instances, remain economically attractive. Also, where gas pipeline networks have already been constructed, as in Bangladesh, Pakistan, Yugoslavia, and Argentina, the incremental cost of additional gas production will likely continue to be equal to or lower than fuel oil costs. Where gas resources have been discovered but not developed, as in Tanzania and Papua New Guinea, the choice between gas and fuel oil is likely to be more difficult and will depend, to a large extent, on the potential size of the domestic market and on the relative cost of alternative fuels. Of course, as with other capital-intensive energy projects of long duration, adequate long-term financing and guaranteed early full capacity utilization will be essential elements in obtaining an acceptable cash flow during the early years of operation.

The power sector consumes the largest share of public sector investment in many developing countries, and the current energy price uncertainties have made planning issues in this sector more complex. New investment plans need to be analyzed for their robustness over a wide range of scenarios and with a more critical eye to flexibility in primary energy sources. Many developing countries need to introduce new methods for reducing risk in their investment decision-making processes. In fact, the domestic and foreign exchange resource constraints and debt service obligations that many developing countries face, together with uncertain fuel prices and exchange rates, tends in many instances to favor investment options that are less lumpy and that are flexible and involve shorter construction periods and lower capital costs. For example, new power plants constructed to use imported or domestic fuels in some instances might be equipped for dual firing (coal/oil/gas) with only a modest increase in capital costs. This would allow the plant to take advantage of future shifts in relative fuel prices. Also, when considering alternative energy sources, at the margin a series of small thermal plants (as compared, for example, with one large hydro project) could provide increased flexibility in adapting to changing supply costs and uncertain demand conditions.

The renewable or household energy sector in most developing countries should not be greatly affected by lower oil prices. Some additional substitution may take place in urban households switching from woodfuels or charcoal to kerosene. However, in general, the lower price of oil alone should not cause major short-term changes in the consumption of wood products, animal wastes, or other residue energy sources. Wind and solar applications so far have not provided large amounts of energy in developing countries, and pending a major technical breakthrough this situation probably will not change.

Over the longer term, of course, the penetration of commercial energy into the household sector is likely to increase. However, the budgetary and balance of payments burden of accelerating this penetration over the short-term is probably too high for most developing countries to sustain. The primary issue to determine through time will be the best way to provide and price LPG, kerosene, and other conventional energy forms to meet growing urban household energy needs at least cost, and in ways helpful to those most in need.

Organization and Financing Issues

Although oil-related investments have fallen in some oil producing developing countries due to lower oil prices, the long-term demand for overall energy-related investments in all developing countries will likely remain high. Satisfying this demand will require large amounts of financial resources, often during periods of extreme resource scarcity. For example, the amount of new energy investment required to support a 4% growth rate in commercial energy demand in developing countries has been estimated to be as high as US\$80 billion/year. Of this amount, roughly 70% could be for electric power and the balance for coal, oil, and gas.

To minimize the amount of new energy investment required and to attract new capital to the sector, developing countries must place more emphasis on innovative financing schemes, efficiency pricing, institutional and organizational strengthening, investment for interfuel substitution which acknowledges uncertainty, and the development of indigenous oil and gas resources where economically justified. These factors are interrelated. By creating an environment which can attract energy investment funds from a variety of sources, countries must provide incentives for an efficient allocation of energy resources and for efficient management of energy enterprises, and vice versa.

A number of innovative financial options have been suggested that might assist in maintaining energy investment programs while minimizing the accrual of new debt. These options include some of the following:

- o more IOC farm-ins or other joint venture arrangements with NOCs;
- o financial leasing arrangements involving dummy offshore companies, commercial banks, and suppliers;
- o operational leasing arrangements in which the lessor also operates and maintains the installations;
- o enclave financing arrangements for power generation in which the owner-operator sells power to a public grid or wheels it to specific consumers;
- o the sale of electricity futures to consumers that desire longer term price contracts;
- o conversion of some portion of country energy debt into leasing arrangements;
- o conversion of some portion of country energy debt into equity with a possible put option to reconvert the equity into debt after a given period;

- o other debt-equity swaps and related operating arrangements; and
- o direct, private equity financing.

Of course, the legislative, regulatory, and contractual implications of the above, and related profit repatriation issues, would have to be thought through in detail.

Partly to assist in attracting financing, a climate of more efficient resource use might be promoted through some fundamental restructuring in which market forces are introduced and greater scope is allowed for private sector involvement, both domestic and international. Clearly, it will be difficult to increase the amount of resources going into the energy sector in developing countries as long as existing resources are used so inefficiently. In an era of fiscal constraints, neither the government nor the public is likely to continue to tolerate the high costs and inefficiencies of many public power, oil and gas monopolies. Power utilities, for example, cannot continue to make up for inefficient and costly practices and occasional white elephant investments by raising tariffs, without creating greater consumer and investor resistance. And, now that the cushion of profits associated with the previous era of high oil prices has been reduced, many national oil, gas, and coal enterprises also will need to consider ways to restructure themselves and to improve their operating efficiency.

The primary issue is not so much what needs to be done but how to do it. There are no magic answers, as each case tends to be a little different. However, underlying the special circumstances of each situation, there is one key factor that must be considered in improving the efficiency of energy sector investment and management: the role of government.

The Role of Government

Many problems relating to management accountability and inefficiencies in energy production, distribution, and consumption in developing countries can be attributed to inappropriate choices in the roles to be played by the public and private sectors. All too often the public sector has tried to undertake more than it can handle given its limited human and financial resources. This has sometimes led to a relative neglect of those things that can only be done by the public sector. By focusing on operating company investment plans, administration, production, distribution, retailing, billing, etc., for example, government can overlook fundamental policy issues and strategic directions relating to energy sector structure, regulation, pricing, and related environmental issues. Many developing countries need to reexamine the role of government in the energy sector, not to eliminate government's role but to define a more productive partnership between it and the public and private operating companies. The merits of the various sector organizational structures of course have to be weighed in each individual case.

Looking Ahead

Although the energy problems facing developing countries are numerous, they are not intractable. Developing country governments are beginning to adjust to the new era of uncertainties by addressing sector inefficiencies and reviewing energy legislation, fiscal regimes, and sector institutions. The roles of government and of market forces are increasingly being debated, and some of the white elephant projects of the past are being discarded. Investment options are being reconsidered. There is certainly a basis for optimism.

Energy Efficiency in Developing Countries

Ian Hume

Overview

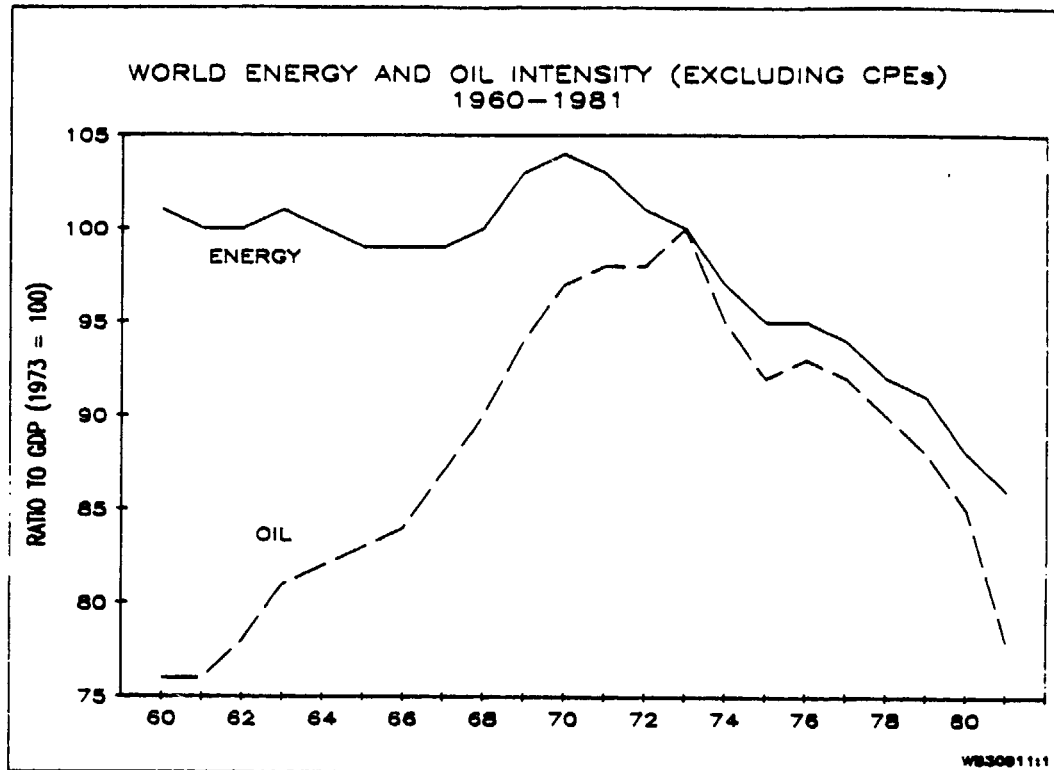
The economic disruption caused by the two oil shocks of the 1970s gave developing countries a compelling incentive to improve the management of their energy supplies. Besides expediting investments to develop indigenous energy sources, many developing countries turned their attention to energy conservation and efficiency improvements as alternatives to importing oil. Since the oil price increases made petroleum and other energy sources appear to be more expensive--and highly intensive in foreign exchange--developing country policymakers began to look for ways to conserve energy. Now that the pressures on oil prices have abated somewhat, one must consider whether this emphasis on energy efficiency is still warranted in developing countries today, and, if so, what priority it should be given relative to the other objectives of energy sector management.

Overall, lower oil prices should not reduce the need for energy efficiency or the priority of conservation and energy efficiency programs in relation to other management objectives. There are several reasons for this. First, oil has proven to be a volatile energy source; it may be cheap today, but it probably will not remain so indefinitely. Furthermore, even though the cost of oil has declined, the cost of other energy sources has not. Consider, for example, those energy sources which are driven by the cost of new dam construction, or coal mines. Second, regardless of the world price of oil, energy economy and conservation efforts are needed to preserve or strengthen the competitiveness of transport and industry--particularly in the cement, petrochemicals, and metallurgy industries, which are heavy users of energy. Third, and most importantly, energy savings actually can provide an alternative form of energy supply, in that it is much cheaper to supply energy by releasing portions from existing supply capacity than it is to add new capacity. Energy efficiency therefore is important as a means of economizing on investment capital. This last point cannot be overemphasized because almost all developing countries suffer from critical shortages of investment capital. In the power sector alone, capital can account for half the cost of every kilowatt-hour produced; clearly the potential for saving capital here by saving kilowatts is very large. On a global scale, power system expansions in the developing world require about \$55 billion a year in investment capital (1982 constant US\$). Energy efficiency and conservation efforts could release much of this precious capital for other priority public uses.

Note: The initial draft of this paper was delivered to an energy workshop organized by the Tata Energy Research Institute in Jaipur, India, in December 1986.

Concepts in Energy Efficiency

Before proceeding, it is important to define what we mean by energy efficiency and to make a distinction between it and the concepts of energy intensity, energy savings, and energy rationalization. Energy intensity is the consumption of energy per unit of product output, or GDP. Energy savings represent a reduction in this intensity. Energy rationalization is a combination of energy savings and switching from higher cost to lower cost fuels.



Energy efficiency is the generic term which, to some degree, embodies all of these concepts. At its center there is a purely technical concept relating to process coefficients of energy transformation. Our concern here, however, is with the broader issues surrounding the economic efficiency of energy supply and use. In the process of producing, delivering, and consuming energy there is a continuum of activities--investment in energy supply capacity; production and transformation; transmission and distribution processes; and final use. The efficiency concept should be applied to all of these activities.

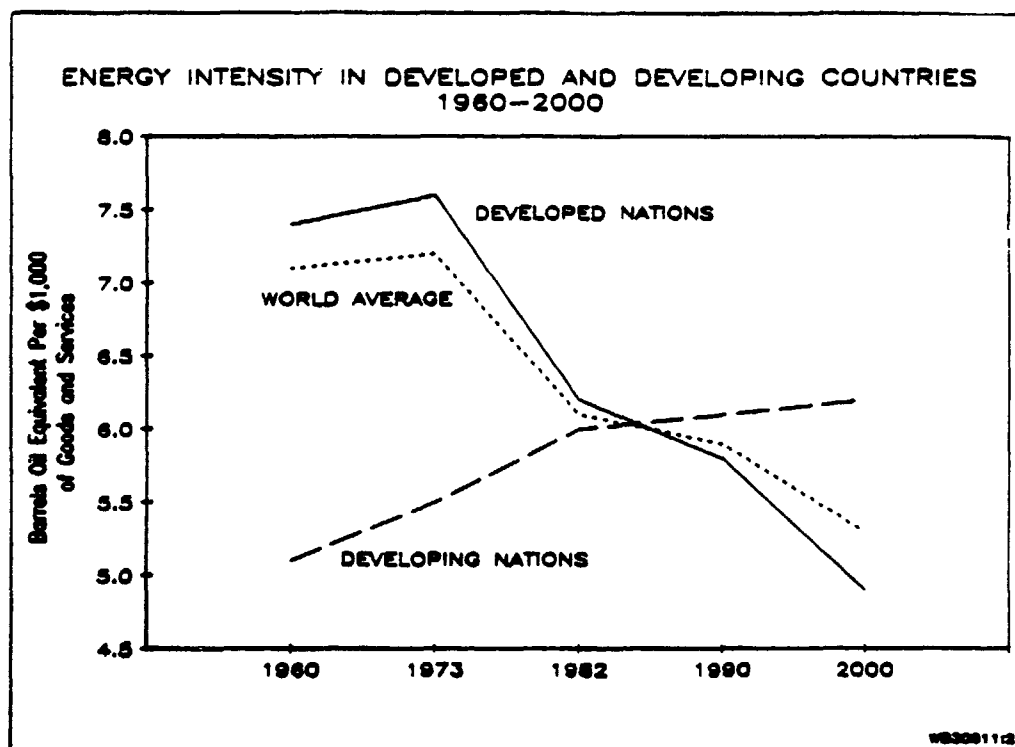
Energy supply may be said to be efficient when the structure of energy investments gives a cost-optimal mix of energy sources. This mix is achieved when energy is produced and delivered at minimum cost for given levels of reliability. Energy end use is considered efficient when energy is consumed at minimum unit rates for given quantities and standards of consumption output. The implementation of both efficiency concepts leaves ample room for improvement in developing countries.

Developing Country Trends

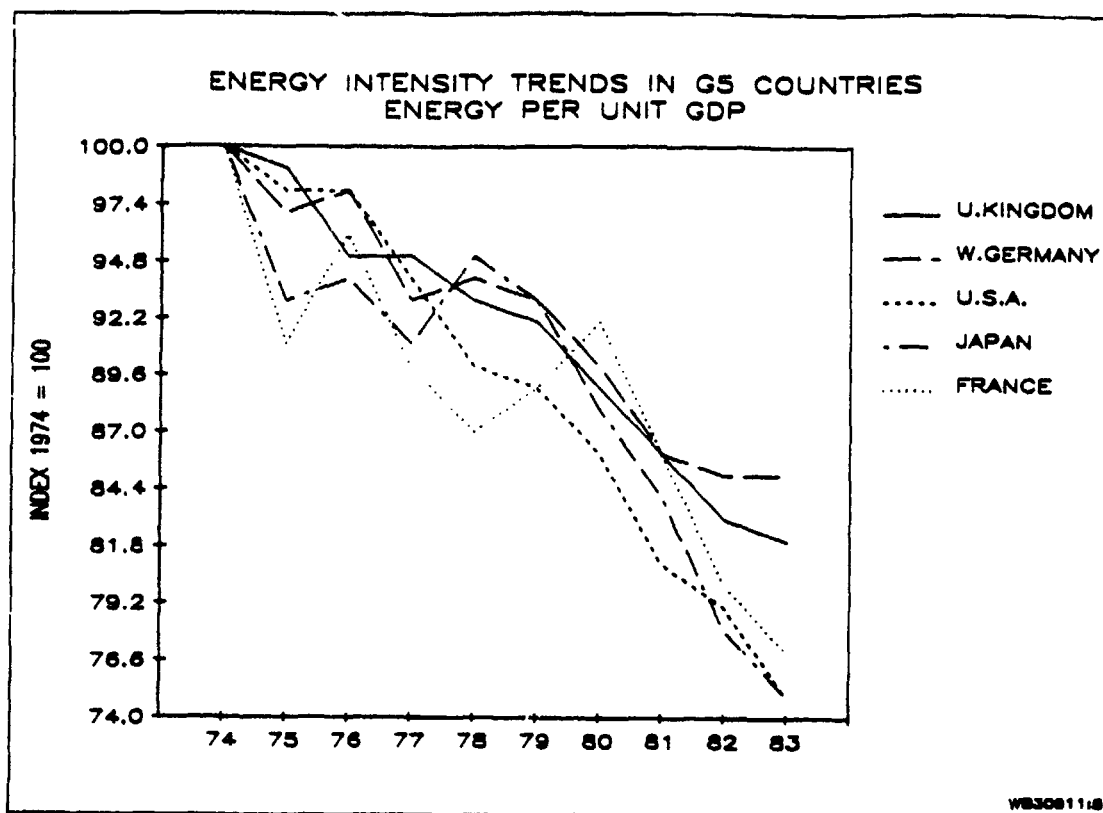
The available country and global data suggest there are at least four broad opportunities for developing countries to strengthen energy efficiency: (a) by reducing their energy intensity levels; (b) by decoupling energy demand from economic growth; (c) by adopting supply policies which strengthen investments, operational practices, and pricing decisions; and (d) by making the largest industrial consumers more efficient users of energy through housekeeping and retrofitting improvements.

Energy Intensity

Although energy intensities worldwide have fallen sharply since the 1970s, energy intensities in developing countries as a whole actually have been increasing. Most, if not all, of the declines in energy intensity have taken place in the developed countries. Two processes account for this difference. One is a "development process" which embodies growth and income effects elicited by structural changes in production and consumption. The other is an "efficiency process" which reflects the cost and pricing effects of improvements in the behavior of energy use coefficients.



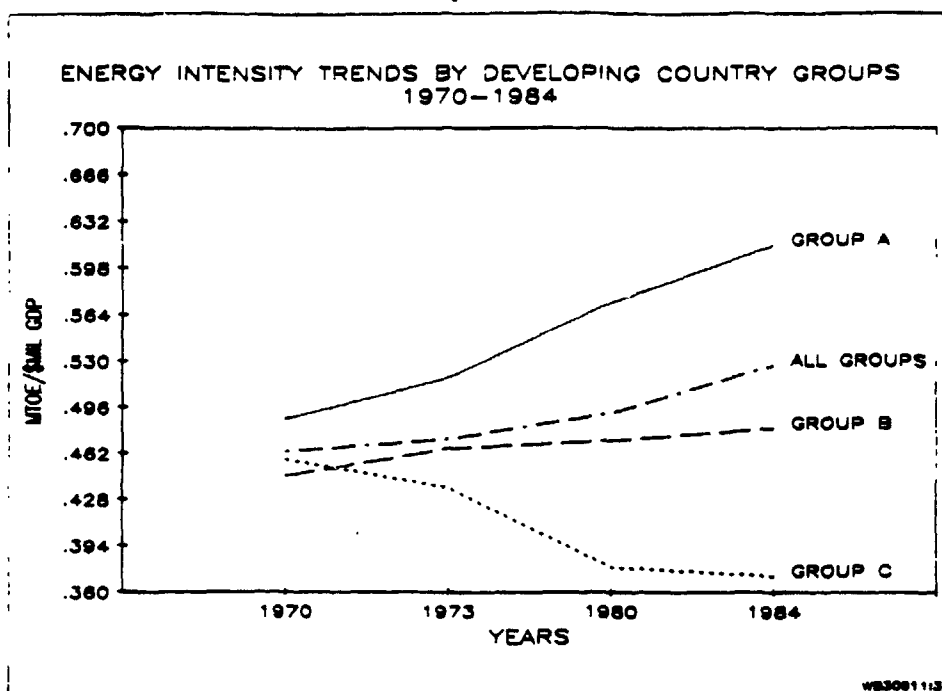
In the developed countries, the downward trend in intensities is consistent with a strong efficiency process, reinforced by a development process which brings about a decline in energy-intensive smokestack industries and the growth of service industries. At the same time, the industrialized countries have responded to past oil shortages with deliberate energy conservation and rationalization policies.



In developing countries, there is evidence that the efficiency process may have reduced energy intensities for certain activities. However, structural elements in the development process largely offset these efficiency improvements. Industrialization in developing countries brings with it urbanization, growth of smokestack industries, electrification, modernization--all of which serve to raise energy intensities. Furthermore, developing countries appear to have been slower to implement efficiency measures, as energy intensities there did not show any appreciable decline until 1981/82. In industrialized countries, on the other hand, a reduction in energy intensity could be observed very soon after the first oil shock. This suggests that developed countries may have been able to decouple economic growth from energy demand much more rapidly than developing countries.

Decoupling Energy Demand and Economic Growth

Developed countries may have been able to separate energy demand from economic growth faster because they instigated efficiency measures at a time when absolute levels of energy consumption were relatively high for their stage of industrialization, and the pattern of economic growth favored less energy-intensive industries. The result was continued economic growth, largely from service industries, and reduced energy consumption overall. Japan is a striking example of this pattern.



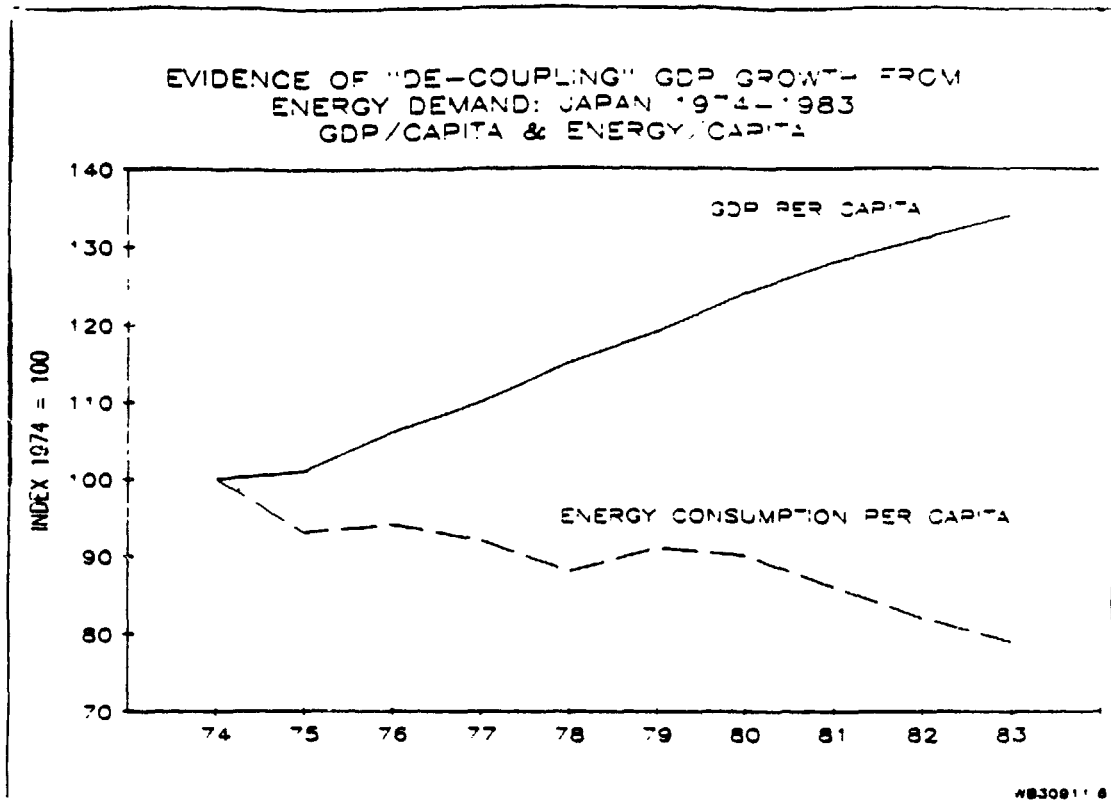
1/ Country Groups:

- Group A - Ecuador, Syria, Greece, India, Turkey, Argentina, Mexico, Zaire, Portugal
- Group B - Thailand, Morocco, Colombia, South Africa, Brazil, Pakistan, Korea, Cameroon, Indonesia
- Group C - Philippines, Malaysia, Tanzania, Israel, Kenya, Zimbabwe

Developing countries probably will not experience such dramatic decoupling because different structural processes are at play. For one, income elasticities of demand for energy are higher, implying that consumers will tend to use more energy as incomes rise in accordance with economic growth. For another thing, price elasticities of demand for energy are lower than in developed countries, implying that consumers are less inclined to curtail consumption in response to increases in energy prices. Some progress can be made to separate energy demand from economic growth by reducing the income elasticity of demand to unity. However, this process is bound to be a slow one, necessarily limited by the pace of economic development in each country. More immediate improvements in energy efficiency can be invoked through the use of conscientious supply-side policies.

Efficiency in Practice: Energy Supply

The concept of efficiency in energy supply covers all the processes embodied in energy sector management: investment, production/generation, transmission, distribution, and final supply for each of the energy sources--power, coal, petroleum, gas, and biofuels. The overriding objective of energy supply decisions should be to secure high quality supplies at the lowest possible investment and operating cost to the economy, and to price these supplies to consumers at a level which reflects their long run marginal costs. Developing countries clearly need to strengthen efficiency in all three areas: investment planning, operational procedures, and pricing.



Examples of investment inefficiencies are not hard to find. In the power sector, which absorbs up to two-thirds of energy investments, inefficiencies often can be observed in the form of excess generating capacity. For example, seven East African countries currently exhibit about 3,000 megawatts of excess power generating capacity over and above reserve margins. At \$2,000 per kilowatt this represents a needless cost of some \$6 billion in investment capital which could be applied productively in other sectors. Latin America shows similar patterns of inefficiency. In Colombia, energy investments (mostly for power) made up about 50% of public sector investments in 1985, even though there already was 50% surplus generating capacity in the system. Few developing countries can afford such large margins of premature capital use.

The power sector also is home to many operational inefficiencies, particularly in the transmission and distribution functions, where losses can be as high as 35% of the total power generated. These inefficiencies include both technical losses and unmetered consumption, which are expected to cause some losses but of a much smaller magnitude--perhaps 4-8%. The World Bank has estimated that countries showing average technical losses of 20% overall could save the capital investment on one full year's demand growth just by reducing these losses to 14%. This is another example where energy efficiency can be employed to save valuable investment capital.

Operational inefficiencies also can be observed in the poor management of spare parts inventories. For want of relatively minor expenditures in the provision of spare parts, some developing countries (such as Turkey and India) suffer disproportionate costs in power outages. While

outages can serve to ration supplies where there is an undersupply of electric power, the disruptions they impose are enormously costly in related economic activity and they do not discriminate between efficient and inefficient power users. Furthermore, power outages can occur even where there is excess generating capacity, particularly if the foreign exchange needed to purchase spare parts is not available.

In the oil and gas sectors, inefficiencies can take several forms. Here artificial contractual and pricing terms set by government agencies for private operators can create false operating economies. These in turn lead to suboptimal investments which prolong the need for costly energy imports. Many countries have refineries (some of them government operated) that generate net economic losses and should be rationalized, privatized, or closed. For example, in Yugoslavia refinery losses are about 1.7% of crude oil input, compared to 0.5-1.0% worldwide, and the refinery's own consumption of energy averages about 7%, compared to a world average of 3-4%. In most developing countries, private sector participation in energy operations could significantly improve operating efficiencies, as well as provide technology, know-how, and equity financing. Although private operators cannot be allowed to dominate the energy supply arena, they nevertheless have an important role to play in the sector which should be encouraged in developing countries.

In the household energy sector, inefficiencies occur in the processes of converting, utilizing, and valuing various forms of biomass cooking and heating fuels. Household energy is the single largest provider of energy in developing countries--often accounting for 60-80% of all energy consumed in a country. Although the markets for household fuels typically are informal or nonexistent, they still allow for sharp discrepancies between the private and social costs of using these fuels. For example, because fuelwood usually is burned at very low heating efficiencies (10-15%), it often is regarded as a free good or else priced at much less than its full cost. This suboptimal pricing encourages excessive felling of trees for fuel which can lay bare entire forests, destroy soil fertility, and jeopardize the very productive base of a country's food supply.

Inefficient pricing can spawn problems in other sectors as well, either because resources are priced below cost or because they are priced at full cost before the economic climate can support it. Either policy can cause distortions in consumption patterns and lead to poor investment decisions or an unbalanced mix of energy fuels. One example of below-cost pricing is Brazil's alcohol program, which imposes a massive subsidy burden on the national budget. Another example is the low level of power tariffs in countries like Egypt and China, which have not adjusted tariffs in more than three decades. Obviously these prices do not send appropriate signals to consumers, and the countries undoubtedly exhibit higher energy intensities as a result.

It is evident there is much that developing countries can do to save energy by taking a critical look at their investments, operational practices, and pricing policies for energy supply. It is equally important for them to look at the area of end use efficiency as a means of saving energy.

End Use Efficiency and Conservation

One of the most expedient methods of improving end use efficiencies in developing countries is to encourage the largest consumers of energy to employ better housekeeping measures and make longer term retrofitting and process modifications to their industrial plants.

AVERAGE ENERGY PRICE AND INCOME ELASTICITIES OF DEMAND FOR MAJOR ECONOMIC REGIONS

COUNTRIES/ ECONOMIES	PRICE ELASTICITIES	INCOME ELASTICITIES
INDUSTRIAL	-0.4 to -0.6	0.7
CENTRALLY PLANNED	-0.1 to -0.3	0.75 to 0.8
DEVELOPING		
OIL-IMPORTERS	-0.2 to -0.4	1.0 to 1.2
OIL-EXPORTERS	-0.1 to -0.3	1.05 to 1.2
MAJOR EXPORTERS OF MANUFACTURERS	-0.2 to -0.4	1.0 to 1.05

Sources: United Nations Energy Statistics; World Bank, Economic Analysis
and Projections Department.

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Luckily for policymakers, just a handful of industrial consumers are responsible for consuming a large share of the total energy used in developing countries. Of the 250 or so major industrial enterprises operating there, only 12 account for about 70% of the energy used. ^{1/} This means that policy actions can be targeted on a very narrow band of industries, with a large payoff potential.

World Bank staff estimate that short-term housekeeping improvements could save as much as 35-66 million tons of oil equivalent (MTOE) per year in

^{1/} The twelve leading energy consumers are: petroleum fuels, petrochemicals, steel, aluminum, fertilizers, cement, glass, bricks and ceramics, pulp and paper, sugar, and finished textiles.

developing countries. An additional 59-111 MTOE potentially could be saved from retrofitting and process modifications. The largest savings possibilities are in the steel, petroleum refining, cement, pulp and paper, and chemical industries.

Every effort should be made to pursue these efficiency improvements vigorously in developing countries. The savings potential is quite large; payback periods are short where investments are needed; and the cost reductions resulting from energy savings should help to boost competition in the affected industries.

Implementing Efficiency Improvements

By now it should be evident that there are many causes of energy inefficiency in developing countries. The very task of producing and delivering secure energy supplies at the scale demanded in these growing economies is an enormous one which places heavy demands on available capital, management and skilled manpower resources, and the political will of governments. Furthermore, institutions in the sector may not always be strong or efficient, decisions regarding large investments with subsector linkages may not be well coordinated, and competition for scarce capital among political and institutional lobbies may constrain supply decisions and interfere with rational pricing. To begin to overcome some of these obstacles, policymakers should follow a few basic principles.

First, efforts should be made to foster an open, competitive economy, as this is the best way to ensure overall economic efficiency and efficiency in energy supply and use.

Second, energy resources should be priced high enough to cover their long run marginal costs. This policy will help policymakers to manage demand effectively and provide the supplying entities with the cash flow needed to finance their maintenance and expansion plans.

Third, investment processes and decision criteria need to be based on sound, objective data. In the power sector, investments should be based on substantive least-cost development programs which can be used to resist pressure from political lobbies and other groups. Clear decision making is particularly crucial at a time when unstable oil prices heighten the uncertainty of many investment choices. Least cost programs for that reason should be risk-adjusted, favoring smaller, more flexible increments to power systems in order to avoid costly mistakes.

Fourth, in managing the sector, government should promote the efficiency of enterprises by clarifying the respective roles of government departments, public utilities, and private operators. In this task, government should confine itself to structuring a regulatory framework which provides maximum autonomy and accountability to these entities and encourages greater private sector participation in energy supply.

Finally, governments should adopt explicit conservation policies that go beyond the steps involved in rational energy pricing. Public awareness efforts, audits of energy use in industry, and other methods to foster energy savings also should be promoted and supported.

Reforming Electric Power Policy in Developing Countries

Mohan Munasinghe and Robert J. Saunders

Introduction

Although the softening of world oil prices in 1986 provided relief to oil importing nations, energy related problems still preoccupy the minds of decision makers in most developing countries. Most of the key energy issues identified during the past decade have not disappeared. Thus, developing country energy investments still average about 25% of total public investments; oil importers still spend 15-20% of export earnings on petroleum imports; and fuelwood shortages and deforestation problems, especially in Africa and Asia, continue unabated. Underlying all of these problems is the need to provide adequate energy resources at reasonable cost in order to fuel economic development. In this respect, the power sector has been acknowledged as a special engine for growth.

The table below shows recent energy investment requirements in several developing countries. Of the total energy investment requirement, the power sector generally accounts for about three-fourths. If the lower oil prices were to cause the world economy to expand, as would be expected other things being equal, economic growth in the developing countries and the demand for their exports would likely increase as well. This, in turn, would spur greater industrial activity and demand for electricity in developing countries, which would create a need for even greater investments to expand supply capacity.

Annual Energy Investment as a Percentage
of Total Public Investment

Below 20%	20-30%	30-40%	Over 40%
Egypt	Botswana	Ecuador	Argentina
Ethiopia	China	India	Brazil
Ghana	Costa Rica	Pakistan	Colombia
Nigeria	Liberia	Philippines	Korea
Sudan	Nepal	Turkey	Mexico

Note: Figures apply to the early 1980s.

Note: The initial draft of this paper was presented at a conference of the International Association of Energy Economists in Boston, Massachusetts in November, 1986.

Unfortunately, the performance of power utilities in developing countries has deteriorated over the past few decades. Accompanying this deterioration has been a shift towards large, monolithic government owned and operated utilities. The formation of these power utilities was based on arguments relating to the need for: economies of scale in planning and operations, improvements in coordination and efficiency, reduced reserve margins and reliability gains, larger and longer term investments, political pressures for nationalization and elimination of foreign ownership, and so on. Although some of these reasons may be valid, there is a growing awareness in third world countries and in the development community that fundamental change is needed to improve efficiency in the power sector. There appears to be special interest in restructuring the sector, decentralizing operations, and obtaining greater private participation, as ways to improve the performance of power utilities.

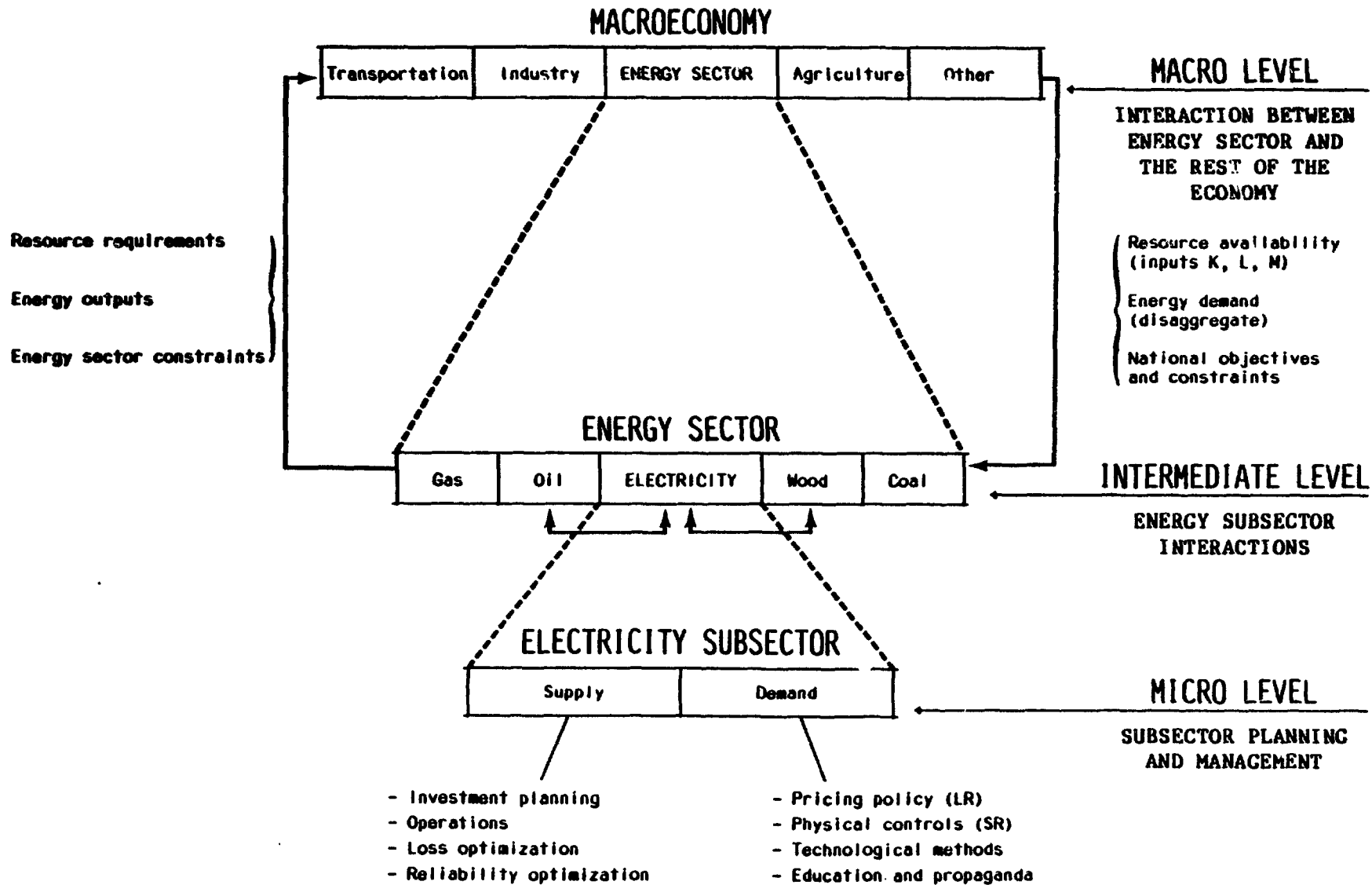
In the course of reforming the power sector, developing country governments also must be relieved of the crippling burden of financing the deficits created by inefficient state-owned electricity enterprises. This need has not only increased pressures for power sector reform but also highlighted the importance of studying the linkages between the power subsector, the energy sector overall, and the macro economy. Clearly, effective power and energy strategies cannot be developed in isolation.

Advantages of an Integrated Approach

A clear understanding of economy-wide energy linkages is vital, no matter what type of political system prevails. It will help decision makers in formulating policies and providing market signals and information that encourage more efficient energy production and use. The scope of such a framework for integrated national energy planning (INEP) and supply-demand management may be clarified by examining the hierarchical structure depicted in Figure 1.

At the highest and most aggregate level, the energy sector must be clearly recognized as part of the whole economy. Therefore, energy planning requires analysis of the links between the energy sector and the rest of the economy. Such links include the energy needs of user groups, the input requirements of energy producers, and the impact on the economy of supply and pricing policies. The second level of the integrated approach treats the energy sector as a separate entity composed of subsectors such as electricity, petroleum products, and so on. This permits detailed analysis, with special emphasis on interactions among the different energy subsectors, substitution possibilities, and the resolution of any resulting policy conflicts. The third and most disaggregate level pertains to analysis within each of the energy subsectors. It is at this lowest hierarchical level that most of the detailed evaluation, planning, and implementation of energy projects is carried out by line institutions (both public and private). In practice, however, the three levels of INEP overlap considerably. Thus, the interactions of electric power problems and linkages at all three levels need to be carefully examined.

**Figure 1:
Integrated National Energy Planning Framework**



This integrated framework facilitates policymaking without implying rigid centralized planning. The flexibility of the process should result in the development of a responsive and up-to-date energy strategy designed to meet national goals. The national energy strategy (of which a power investment program and pricing policy are important elements) may be implemented through a set of energy supply and demand management policies and programs that make effective use of decentralized market forces and incentives.

The policy instruments available to third world governments to achieve optimal energy management include: (a) physical controls; (b) technical methods; (c) direct investments or investment-inducing policies; (d) education and promotion; and (e) pricing, taxes, subsidies, and other financial incentives. Since these tools are interrelated, their use should be closely coordinated.

There are several major constraints to effective policy formulation and implementation in many developing countries. These include: (a) inappropriate government interventions; (b) poor institutional frameworks and inadequate incentives for efficient management; (c) insufficient manpower and other resources; (d) weak analytical tools; (e) inadequate policy instruments; and (f) market distortions and low incomes.

Next, we examine specific power subsector issues within the wider INEP framework summarized above. It is convenient to begin by recalling that economic efficiency requires both: (a) efficient electricity use by providing price signals that ensure optimal consumption patterns and resource allocation; and (b) efficient production of electricity by ensuring least-cost supply through optional long-term investment planning, as well as capable shorter-term power system operation and management. Each of these aspects is discussed more fully below.

Pricing Policy

Fifteen years ago, electric power pricing policy in most countries was determined mainly on the basis of financial or accounting criteria, e.g., raising sufficient sales revenues to meet operating expenses and debt service requirements, while providing a reasonable contribution towards the capital needed for future power system expansion. In recent years, however, more emphasis in developing countries has been placed on the use of economic efficiency principles. In particular, a great deal of attention has been paid to marginal cost pricing policies.

A comprehensive approach to power pricing recognizes the existence of several objectives or criteria, some of which are inconsistent. First, economic resources must be allocated efficiently not only among different sectors of the economy, but within the electric power sector itself. Second, certain principles relating to fairness and equity must be satisfied, including: (a) a fair allocation of costs among consumers according to the burdens they impose on the system; (b) assurance of a reasonable degree of price stability; and (c) provision of a minimum level of service to low-income

power consumers where feasible. Third, power prices should raise sufficient revenues to meet the financial requirements of the subsector. Fourth, the power tariff structure must be simple enough to facilitate the metering and billing of customers. Finally, political requirements sometimes exist, such as subsidized electricity supply to certain sectors or geographic areas.

Since the above criteria often conflict with one another, it is necessary to accept certain tradeoffs among them. The long-run marginal cost (LRMC) approach to price setting has both the analytical rigor and inherent flexibility to provide a tariff structure that can be responsive to most of these basic objectives. In the first stage of calculating LRMC, the economic (first-best) efficiency objectives of tariff setting are pursued because the method of calculation is based on estimates of future economic resource costs (rather than sunk costs) and it can incorporate economic considerations such as shadow prices and externalities. The structuring of marginal costs attempts an efficient and fair allocation of the tariff burden on consumers. In the second stage of developing an LRMC-based tariff, deviations from strict LRMC are considered in order to meet important financial, as well as social, economic (second-best), and political criteria. This second stage of adjusting the strict LRMC is generally as important as the first-stage calculation, especially in the context of developing countries.

The LRMC approach provides an explicit framework for analyzing system costs and setting tariffs. If departures from the strict LRMC are required for non-economic reasons, then the economic efficiency cost of these deviations may be estimated, even on a rough basis, by comparing the impact of the modified tariff relative to the (benchmark) strict LRMC. Furthermore, since the cost structure may be studied in considerable detail during the LRMC calculations, this analysis helps to pinpoint weaknesses and inefficiencies in the various parts of the power system, such as over-investment, unbalanced investment or excessive losses at the generation, transmission, and distribution levels in different geographic areas. This aspect is particularly useful in system-expansion planning.

Finally, any LRMC-based tariff is a compromise among many different objectives. Therefore, there is no "ideal" tariff. By using the LRMC benchmark approach, it is possible to revise and improve the tariff on a consistent and ongoing basis and thereby approach an efficiency based price over a period of several years. This protects long-standing consumers from having to absorb large, abrupt price changes all at once. Recent advances in low cost metering and switching equipment, which have made possible selective spot pricing and better load control, have made it possible to consider more sophisticated approaches to balancing supply and demand when appropriate.

Investment Policy

Efficiency based pricing of electricity (based on marginal cost principles) assumes that the power system is optimally planned and efficiently operated. This is important, even from a practical point of view, since an inefficient power utility that is routinely permitted to pass on excessively

high costs to consumers, under the umbrella of marginal cost pricing, will have very little incentive to reduce costs and produce more efficiently. There are also a number of solid analytical reasons for insisting on supply efficiency as a prerequisite to LRMC-based pricing. These are discussed below.

Optimal Reliability and Traditional Least Cost Planning

As stated earlier, decision makers in the electric power sector are concerned principally with investment and pricing policies. The close relationship between optimal investment and pricing policies has been recognized for some time. However, recent theoretical work has emphasized that the optimal conditions for price and capacity levels must be simultaneously satisfied to maximize the net social benefits of electricity consumption. In this context, determining the optimal capacity level is equivalent to establishing the optimal level of reliability since capacity additions do improve reliability.

The complex analysis underlying the joint optimality conditions can be summarized simply, as follows. The optimal price is equal to the marginal cost of supply. Simultaneously, the optimal reliability (capacity) level is defined by the point at which the marginal cost of increasing reliability is exactly equal to the corresponding decline in outage costs incurred by consumers subject to power failures, poor voltage, and frequency variations. In conventional economic analysis, the short-run marginal cost (SRMC) is the cost of meeting additional electricity consumption, with capacity fixed, while the LRMC is the cost of providing an increase in consumption (sustained indefinitely into the future) in a situation where optimal capacity adjustments are possible. When the system is optimally planned and operated (i.e., capacity and reliability are optimal), SRMC and LRMC coincide. However, if the system plan is sub-optimal, significant deviations between SRMC and LRMC will have to be resolved within the pricing policy framework. Finally, if there are substantial outage costs outside the peak period, then the optimal marginal capacity costs may be allocated among the different rating periods (i.e., peak, intermediate, and off-peak) in proportion to the corresponding marginal outage costs.

Except under special conditions (e.g., when spot pricing is feasible), electricity tariffs often are not readily subject to change, so the simultaneous optimization of price and capacity is a theoretical ideal. Therefore, from a practical point of view, it may be appropriate (or necessary) to separate the joint price and reliability optimization conditions by attempting to "optimize" reliability in the presence of fixed or given tariffs, at least on the first round. Once the optimal reliability and investment levels (subject to given prices as defined above) are determined, tariffs can be revised to reflect any changes in the marginal cost of supplying electricity implied by the new reliability level. Using this new level of tariffs and resulting demand, reliability and capacity can be reoptimized iteratively. We note that application of the marginal cost pricing rule has been attempted in several industrial countries (most notably France), and while interpretations vary among practitioners, the approach has gained wide acceptability. The optimal reliability rule is more difficult to

apply. This is mainly because shortage costs are not easy to estimate, although considerable progress has been made in estimating these costs in recent years.

It must be emphasized that the reliability (or supply quality) optimization model strengthens rather than replaces the conventional least cost criterion. In the conventional approach to power system design and planning, costs are minimized subject to supplying the load at some (arbitrarily) given standard of supply. With the revised approach, it is possible to determine an optimal reliability level, by using a social cost-benefit approach (based on a national rather than a utility-specific viewpoint) to evaluate the inherent trade-off between the increase in power system supply costs required to achieve a higher level of reliability, and the corresponding decline in consumer shortage costs. It would be possible then to design the power system to meet the forecast load, subject to the new reliability requirement, using the traditional least-cost planning techniques. This would permit the application of existing sophisticated least cost system planning models.

Finally, it is worthwhile noting that the present decision making climate is characterized by high levels of uncertainty with regard to trade and economic conditions, energy prices, future demand, interest rates, currency values, and technological change. Consequently, there is much greater scope in developing countries to use models which identify risk-diversifying energy policy options that are robust over a wide range of exogenous scenarios, rather than cost minimizing, deterministic but risky solutions that were more appropriate for the narrower band of eventualities which existed in the past.

Institutional and Financing Options

In designing energy policies to stimulate a more efficient use of national resources under a broader range of possible economic conditions, developing country decision makers have a number of alternatives to consider. These include both attacking institutional efficiency issues and considering new financing methods. Among the ways in which developing countries might improve the efficiency of their public energy enterprises could be to allow them greater autonomy and institute management reforms, or could be to restructure them and decentralize some of their functions.

Greater Autonomy and Management Reforms

Although many difficulties have plagued developing country power utilities, probably the most pervasive has been undue government interference in organizational and operational matters. Such interference has adversely affected least cost procurement and investment decisions, hampered attempts to raise prices to economic efficiency levels, mandated low salaries tied to civil service levels, and promoted excessive staffing. This in turn has resulted in management who are not held accountable, the loss of experienced staff due to uncompetitive employment conditions and poor job satisfaction, weak planning and demand forecasting, inefficient operation and maintenance, high losses, and poor financial monitoring, controls, and revenue collection.

In order to address these difficulties, an important principle must be recognized--that the complexity of energy problems and the scarcity of resources and managerial talent in developing countries requires that each set of issues be dealt with at that level of decision making and management best suited to analyzing the difficulty and implementing the solution. This hierarchical approach corresponds closely to the INEP concept developed earlier in this paper. Thus, political decision makers, senior government officials, and ministry level staff should focus on critical macroeconomic issues and energy sector strategy and policy, in order to determine global expectations of power utility performance. The senior management of a power company, appropriately buffered by an independent board of directors and operating in a known regulatory framework, would then conduct its daily operations free from government interference, to meet the overall policy objectives and service targets within the regulatory guidelines. As far as possible, the utility management should be assured of continuity at the top, even in the face of political change. While the enterprise is provided wider autonomy, it would become more accountable in terms of performance measured against an agreed set of specific objectives and monitored indicators. The senior management of the power enterprise would be well advised to meet regularly with government and consumer representatives, to discuss performance problems and successes.

In introducing such a structure, initial changes in enterprise management may be required, to mirror changes in the utility's external environment. The enterprise's internal organizational structure and procedures may also be inadequate. Once again, the fundamental principles that will help to address these problems are delegation of authority and accountability.

In many developing country power utilities, the senior management attempts to deal with all problems, and trivial issues often get more attention than critical ones. If middle-level managers could be adequately trained, senior managers could (by appropriate delegation of tasks) free themselves to deal with higher level strategic initiatives. Middle management would become accountable for its performance through an agreed set of performance indicators, while obtaining greater responsibility and latitude to make decisions. This process could be repeated down to the lowest working levels. Obviously, staff training and education at all levels and stages of career development would play a critical role in ensuring the success of such an approach.

Restructuring and Decentralization

The natural monopoly characteristics of some power enterprise functions, and government's willingness to manipulate these enterprises for general policy purposes, are in many countries accepted as sufficient reasons for maintaining large centralized public sector organizations. Nevertheless, the observed problems inherent in motivating the managers of state enterprises in developing countries to be cost conscious, innovative, and be responsive to consumer needs indicate a need for more fundamental change. It could be worthwhile to trade off some of the perceived economies of scale in energy enterprises for other organizational structures which provide greater built-in

incentives for management efficiency and responsiveness to consumers. In particular, varying the forms of ownership and regulation in the power sector should be considered.

As long as a given regulatory framework prevails, it can be argued that the form of ownership (private or public) does not, by itself, affect operating efficiency. The main point is that, to the extent possible, the introduction of management efficiency incentives such as those brought about by competitive market forces should be encouraged. Options for private and cooperative ownership of energy enterprises could include both local and foreign participation as well as joint ventures. Governments may wish to divest themselves of either all or part of their ownership and control over certain enterprises, functions, or organizational structures. Thus, they might provide an environment in which governments, enterprise managers, and energy consumers are all better off. A first step towards decentralization could be for government-owned power enterprises to competitively contract out activities or functions which are better handled by others. Many companies already subcontract various construction-related activities. Some portions of the billing and collection process, or routine maintenance, are on occasion also subcontracted. These arrangements usually have the advantages of lower costs and greater programming flexibility.

There are also opportunities for decentralization on a spatial basis. For example, larger countries may have independent regional power grids. Power distribution companies could be separate by municipality, with perhaps limited overlap in some fringe franchise areas, and have the right to purchase from various suppliers, when feasible. If private participation were allowed, large power consumers might also be able to become legitimate shareholders who would be concerned not only with service efficiency but also with the financial viability of the power company.

In power generation, there is potential for efficiency improvements through divestiture. While the bulk power transmission and distribution functions might be regarded as having more natural monopoly common carrier-type characteristics, this is not so with generation. In fact, there is substantial scope for competition in power generation with independent (perhaps foreign-owned enclave) producers selling to a central grid, as in the case of large industrial cogeneration. For example, in the U.S., the Public Utilities Regulatory Policies Act of 1978 (PURPA) specifically encourages small, privately-owned suppliers to generate electricity in various ways for sale to the public grid. As a result, there are now a large number of small companies producing electricity, presumably with marginal costs below those incurred by traditional large utilities. Similar laws have been passed elsewhere and are beginning to have an impact.

Appropriate legislation and innovative contractual arrangements could broaden the scope for cogeneration and free generation in developing countries. Larger countries might find small entrepreneurs ready to invest in small hydro or similar generation facilities. The advantage to the power company would be a deemphasis on large, lumpy, capital-intensive projects, together with the fact that the cogeneration and free generation companies would put up all or part of the capital and be paid only out of revenues from

power sold at guaranteed prices. For larger enclave generation facilities (perhaps peat, coal or nuclear), the concept would be that a foreign investor finance and build the plant, operate and maintain it for an agreed period, and be repaid out of power sold at formula based guaranteed prices. A portion of the revenue would have to be convertible into foreign currency and agreed profits allowed to be repatriated.

Financing Options

Given debt problems and resource constraints, developing countries increasingly are considering more innovative financing options, some of which have been used in the industrialized countries. Some of the financial instruments that are now being studied in third world nations include: (a) non-recourse and limited recourse financing (or project-specific financing); (b) leasing of individual pieces of equipment or whole plants, by local or foreign investors; (c) private ownership or operation of generation and distribution facilities; (d) counter trade, involving barter type exchange of specific export goods for energy imports; (e) developing financial instruments to finance local costs, often involving the creation of new financial intermediaries; (f) revenue bonds, with yields tied to enterprise profitability; (g) tax-exempt bonds; and (h) sale of electricity futures, to those that seek more stable, longer term electricity price contracts.

The Multilateral Investment Guarantee Agency (MIGA), being created by the World Bank, could also play a key role beginning in 1988. This agency will seek to promote the flow of international capital to developing countries by providing guarantees (on a fee basis) against the following non-commercial forms of risk: (a) transfer risk, arising from host government restrictions against convertibility and transfer of foreign exchange; (b) loss risk, resulting from legislative or administrative action (or omission) of the host government that leads to loss of ownership, control or benefits; (c) contract repudiation risk, when the outside investor has no recourse to an adequate forum, faces undue delays, or is unable to enforce a favorable judgment; and (d) war and civil disturbance risk.

The Issues: A Summary

If electric power is to be available to feed the growth engine of the developing world, adequate financing, optimum planning, and efficient organization and management are the key areas to be addressed. These items are interrelated and as time passes, addressing them head on is becoming more and more critical.

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Alternative Ways of Financing Power Systems

Anthony A. Churchill

Traditional Financing Sources

In the developed countries, where well-established electric power systems exist, the demand for electric power is unlikely to grow at anything like the rates being experienced in the developing countries. Technology, demographics, and the lower marginal energy requirements of high income societies all work together to moderate the increase in the demand for energy. However, these same factors will insure a continued rapid growth in the demand for energy and, in particular, electric power in the developing countries. Over the next decade the developing countries will account for increasing shares of additional electric power installed.

The price of oil and alternative fuels will determine the types of plant to be built, but regardless of plant type, the major requirement is for capital. Few outputs are as capital-intensive as electric power.

Prior to World War II, much of this capital was financed through private means. Power companies generally were privately owned and relied on both domestic and foreign capital markets to raise the necessary resources. Following the War, rapid growth in demand and the recognition by governments of the importance of this sector to general economic growth resulted in a greater reliance on public sources of capital. Most companies became state enterprises relying on government savings and credit to finance their expansion. The World Bank was an important part of this process. Most of the power systems in the developing countries have received, and continue to receive, substantial support from the Bank and other multilateral and bilateral funding institutions. There is increasing recognition, however, that these sources of capital are no longer adequate to meet growing and urgent needs, for three reasons.

First, as these countries have expanded their economies, as they have become more urbanized and more industrialized, the absolute size of the capital requirements for electric power have grown many times larger than those of primarily rural societies just beginning the growth process. Today there are single power projects which, in real terms, require more capital than the total funds available from the Bank in any one year in the 1950s or 1960s.

Note: The initial draft of this paper was presented at the symposium: "International Build Own and Operate Projects," held in London on February 6, 1987.

Second, the growth process has placed enormous demands upon the limited resources of the public sector. The power sector is only one of many claimants. Today it is not unusual to find from one-quarter to one-third of public investment resources going to electric power. And it is still not enough.

Third, the experience of the last few decades has revealed many of the disadvantages of relying on public ownership and public credit. In spite of valiant attempts, it has not always been possible to isolate the power sector from the inherent inefficiencies of government. These inefficiencies can be costly in a sector as capital-intensive as electric power. The failure to adequately maintain costly plant and equipment, for example, can result not only in loss of the equipment but also loss in the output of other firms for which power is a critical input.

Alternatives to Traditional Sources

Several things need to be done--both to raise the capital required and to improve the efficiency with which it is used. The improvements in efficiency are the key to facilitating change. Without the improvements in efficiency, there are few additional benefits to be shared between investors, owners, and consumers.

For governments, the most obvious advantage of considering alternative financing mechanisms is the additional capital that can be raised. Efficiency concerns are generally of secondary importance. For the investor, it is simply the rate of return appropriately discounted for risk. Efficiency is only important to the extent that it reduces risks or raises the rate of return. In both cases efficiency concerns play a secondary role to the primary motives of both parties. This is unfortunate because both parties will gain only if risks and efficiency are appropriately balanced.

Raising Additional Capital

Consider first the matter of raising additional capital or investment funds. Unless investors are willing to put some of their own capital or credit at risk, there is little to be gained by the government in entering into agreements for private participation in plant ownership and operation. Demands by investors for government guarantees on capital and debt simply shift the burden to the government's limited credit resources, with little or no perceived benefits to the government. In fact, the political costs may be considerable. Existing institutions in the power business are likely to resist any shifting of responsibilities. Questions concerning loss of sovereignty will inevitably be raised.

If governments wish to raise additional funds, they must make it attractive enough for investors to be willing to take on some of the credit risks. This means providing an investment climate in which investors are willing to take normal commercial risks. Instability of pricing policies, including foreign exchange, lack of political stability, poor past

performance, and a host of other factors increases the risks to investors in most countries and therefore raises the costs of private capital to government.

Improving the general investment climate is an obvious first step but, in practice, a difficult one to accomplish. Given the past record, investors' expectations are likely to change only slowly. The process must be one where small steps are taken to improve confidence and to allow private investors gradually to share in a greater proportion of the risks. Attempts to do too much too quickly will disappoint both governments and investors.

This is where focusing on the efficiency gains can be important. Identifying the net gains to be shared by inviting private capital to participate in the ownership and operation of plants can be an important first step in introducing a more realistic framework at the bargaining table. These gains can be found in a number of places.

Identifying Efficiency Gains

The sources of gain will vary from country to country but most will be found where the private sector is able to build and operate plants at lower cost and with improved reliability. These lower costs can be the result of a variety of factors, from improved procurement practices to better incentives for labor and management. A casual examination of the costs and performance of typical developing country utilities suggests the potential gains are significant and could result in cost reductions of 25-50%.

How these gains are to be shared and exchanged is a matter for bargaining. The more that investors demand in protection from exchange risks, profit repatriation, etc., the less interest the government has in sharing in the gains. Similarly, the more that governments frustrate the investor's attempts to improve efficiency, for example, through customs procedures, labor requirements, etc., the less interest the investor has in taking any risk. Both parties need to be flexible and aware of the needs of the other.

Governments, in particular, need to be aware not just of the present deal but also of its impact on future negotiations. There may be ways for the present, perhaps modest, gains in additional capital and improved efficiency to be parlayed into even more gains in the future. In this manner, the experience may be used to establish a new way of doing business.

A common feature of the bargaining process usually is a lack of imagination on the part of all parties concerned. Determination to give away nothing and to take no risks is hardly the atmosphere in which growth promoting changes are likely to occur. Mutual suspicion usually leads to bad bargains.

There are several elements that go into establishing a more imaginative bargaining framework. The capital markets of most developing countries are often more underdeveloped than necessary. There is generally a great shortage of readily tradable securities, and local investors often prefer to deposit their assets in foreign banks. Yet if one studies the

history of North American and European capital markets, the issuing of securities by large public companies provided the very foundations for developing the capital markets. Developing countries generally have precluded this possibility by making the financing of these public works an exclusive prerogative of the treasury.

Encouraging Local Private Investment

The possibility of expanding the increased interest in private foreign investment to include local private investors should be explored. This system has a number of advantages for all concerned. For the government, the encouragement of the local capital market has to be an important developmental goal. For local investors, joining in with a large, partially foreign-financed enterprise may offer an attractive alternative to Miami bank deposits. For both the government and the foreign investor, raising some capital in the domestic market may resolve some of the difficult issues over repatriation of profits and convertibility of local currencies. For the government, the existence of local interests may ease some of the political problems and, at the same time, provide some assurances to the foreign investor to know that his interests coincide with local interests.

In practice, there are many ways to enlist local private financing. The number of special incentives that have to be offered to local investors will depend on the state of the local capital market. Local investors may be willing to accept shares valued in local currency as long as dividends receive the same type of treatment given the foreign owners--perhaps in foreign exchange. The foreign shareholders could be permitted (or required) to sell (or buy) part of their shares each year in the local market. Foreign banks now holding non-performing government loans could be encouraged to swap these debts for equity or other forms of financial participation.

The objective is to establish a local market in which shares or debt instruments held by both local and foreign nationals can be traded. The existence of such a market will improve the liquidity and acceptability of private participation in power and similar types of investments, as well as provide a channel for encouraging local savings.

Obtaining local private financing does require, however, that governments be prepared to negotiate over a broader range of issues than is typically the case where negotiations are left to the national power company and the interested investors. The Ministry of Finance and other parts of the government need to be party to the negotiations so that the broader, longer range interests of the country can be taken into account.

Other areas may have been overlooked in the relationship between potential investors and governments and their national monopolies. One of the unique features of the electricity sector is the existence usually of only one purchaser of the output. This puts a great deal of stress on the negotiations over what quantities are to be sold, at what times, and at what price. Investors try to minimize the risks through some form of take or pay contract with various provisions to insure the pass-through of cost uncertainties such

as changes in fuel prices or exchange rates. In these cases, the investors are simply suppliers of a product where risks are minimized and profit margins guaranteed by the government. Incentives for improved efficiency and any entrepreneurial activities are kept to a minimum.

Clearly this can be improved upon. Countries might well benefit from some loosening up of the market structure. For example, it may not be necessary for foreign investors to be relegated merely to supplying base load. Many developing countries are far from the point of needing the national grid to extend to all parts of the country. Perhaps investors (both local and foreign) could be invited to supply and distribute power in isolated markets, in competition with the national monopoly. Or private owners of plants might be allowed to expand their markets at their own risk, perhaps to large industrial consumers. Alternatively, plant owners might invest with large industrial users in cogeneration of heat and electricity, selling some of the power to the grid or to other consumers.

There are undoubtedly other variations of market structure that can be used to enhance the opportunities for entrepreneurial activities in the sector. There is equally little doubt that existing institutions in the power sector will oppose such moves. Technical, safety, and other reasons will be given, some valid, some not. Experience in the developed countries suggests that many of the problems can be solved and that large gains in efficiency are possible. Again, it requires that governments examine the whole question of private investment in this sector from a much broader perspective than is presently the case.

The World Bank is interested in exploring these and other opportunities for improving the investment climate for private sector participation in the power sector. It is clear that the future capital demands of this sector require a reexamination of the premises under which most capacity has been installed and operated in recent decades. The World Bank has a role to play in this process.

World Bank Role

Nearly four decades of continuous investment in this sector places the World Bank in a unique position to be able to encourage existing utilities to accept a greater degree of diversity and competition in the sector. It can advise them on the advantages and disadvantages of the many alternatives open to them. It can support, through financial and other means, their efforts to adapt to the requirements of a changing environment.

But more important will be the Bank's efforts to persuade governments to broaden their whole approach to private investments in this sector. Governments will need assistance to insure that the process fully takes into account the legitimate concerns of the public, that private monopolies are not simply substituted for public monopolies. All of this will require a regulatory framework that does not yet exist in most countries. For the most part, there are no rules governing the performance of private

operators. In many cases, their operations are prohibited. Governments will be reluctant to expand private sector participation without some assurances that, first, the benefits are sufficiently large, and second, that adequate controls can be developed to safeguard public interests.

The World Bank also has a variety of direct and indirect means to support private investors. The new Multilateral Investment Guarantee Agency (MIGA), soon to be in operation, should be able to insure against some of the risks faced by foreign investors when dealing with sovereign governments. The Bank's participation in the funding of privately sponsored projects can also ease investors' concerns. This can be done directly through the participation of the IFC as one of the parties in a joint venture, or more indirectly by the Bank funding the government or its power agency's share in any such venture.

But more important than any of these measures will be the Bank's efforts to assure all parties involved that their legitimate interests can be adequately taken into account and safeguarded within a framework that provides mutual benefits to all. This can be done by providing a technical appraisal of the costs and benefits of the alternatives, by bringing to the attention of all concerned what has worked and has not worked in other countries, and, in general, by providing its good offices to assist in reaching agreements based on mutual trust and understanding.

Financial Investments in the Petroleum Industry

Philippe Bourcier

Introduction

The precipitous drop in international crude oil prices has had a most pervasive effect on the economies of all countries and has raised a special new set of problems for the developing countries. The oil exporting countries are faced with large reductions in foreign exchange earnings which threaten their financial viability. The oil importing countries are benefitting from lower oil prices but still find it difficult to provide the amount of energy supplies needed to support their economic growth at reasonable cost.

This paper presents an historical view of the energy situation in developing countries, focusing on the constraints that will affect their investment decisions and the difficulties associated with planning in a climate of uncertain oil prices. It highlights the difficulties in mobilizing financial resources for energy development at a time when they are becoming more scarce. The paper also suggests adjustments that might be needed to make the energy sector more competitive and efficient and thus attractive to outside investors. It identifies the World Bank's role in assisting the developing countries in resolving these important issues.

Historical Perspective

The low oil prices of the 1960s and early 1970s led to a rapid increase in oil consumption, the substitution by industry of fuel oil for coal on a massive scale, and increased reliance on imports--often at the expense of domestic production. At the same time, large investments were made in the downstream sector (refining and power generation) to support economic growth.

Demand-Side Effects

The situation changed as a result of the 1973-74 embargo. On the demand side, industry switched to alternative energy sources such as hydropower, nuclear energy, coal, natural gas, and geothermal energy. Where possible, oil burning facilities, such as power and cement plants, were modified to burn coal or, to a lesser extent, domestic natural gas. This

Note: The initial draft of this paper was prepared for The World Petroleum Conference held in Paris in November 1986.

practice was followed even if the high investment costs of conversion were not fully justified by the fuel cost savings or the age of the facility. Industrial consumers, under pressure of higher energy prices, also invested in energy saving measures such as more efficient manufacturing processes, heat recovery, and better insulation. The housing sector, especially in colder climates, reduced its oil demand by switching fuels and by improving insulation. Only in the transport sector was there no effective substitution made for petroleum fuels. The impact of these measures affected primarily industrial countries, although it was also felt in LDCs when oil demand slowed down to historical lows.

In high consuming industrialized and developing countries, interfuel substitution and conservation reduced the share of oil consumption in total primary energy consumption from 49% in 1973 to 41% in 1984. In the developing countries alone, the share of oil consumption dropped from 50.7% in 1973 to 44% in 1984. In terms of volume, however, world oil consumption increased from about 2.3 billion tons in 1973 to some 2.9 billion tons in 1984.

The oil producing industry responded to the high prices of the post 1973-1974 period by shifting their investment from the downstream to upstream facilities. In LDCs, public sector resources were committed to exploration and production activities, thereby capturing the economic rents from indigenous production rather than relying on imports. In the process, the oil industry brought into production relatively high-cost oil when compared to production costs in many OPEC countries. The development of small fields with higher production costs, deep drilling projects onshore and offshore, and investment in enhanced oil recovery projects and in "stripper" wells all contributed to the flow of higher cost oil. During this period, most of the increase in supply came from non-OPEC oil-exporting developing countries, led by Mexico. There were considerable production increases in other countries as well, notably Egypt, Malaysia, Oman, and the People's Republic of China and more recently, Colombia and North Yemen.

Production of Petroleum in Non-OPEC Oil-Exporting Developing Countries
(Million tons)

Country	1973	1979	1984
Angola	8.1	7.2	10.3
Bahrain	3.4	2.6	2.3
Brunei	11.4	13.1	8.2
Cameroon	--	2.0	6.5
China	53.6	106.2	114.6
Congo	2.1	2.8	6.0
Egypt	8.5	25.5	41.9
Malaysia	4.3	13.6	21.7
Mexico	25.8	80.9	152.8
Oman	14.6	14.6	20.0
Peru	3.5	9.5	9.1
Syria	5.5	8.7	9.5
Trinidad and Tobago	8.8	11.1	8.8
Tunisia	3.9	5.5	5.5
Total	153.5	303.3	417.2

Source: United Nations Energy Statistics; World Bank Data.

In the oil-importing developing countries, Brazil and India have been responsible for most of the production increase; in Brazil, production rose from 8.4 million tons in 1979 to 23.7 million tons in 1984; in India, production rose from 12.8 million tons to 28 million tons.

To develop these resources, the petroleum industry (including national oil companies of developing countries) spent an unprecedented sum on exploration and production. The exact tally is unknown, but a large share of these investments in LDCs was financed through external borrowings which contributed to the current debt crisis. This policy of debt financing was justified by the expectation that prices would remain high and that the exploration for and development of domestic resources would remain financially and economically attractive. At the same time, the international oil industry increased its capital expenditure, particularly in upstream exploration and production in non-OPEC countries, thus providing additional sources of capital to LDCs.

Outlook

Any discussion of future energy investment and related issues must make assumptions about oil prices and supply and demand balances. While this is difficult to do, the World Bank believes that prices are unlikely to go back up to the pre-1979 levels in the medium term.

Along with the low forecasts for oil prices, the share of petroleum in the global consumption of commercial energy is projected to continue to decline from about 40% in 1985 to around 33-35% in 2000. This trend assumes that the investments in energy conservation, improved efficiency, and fuel substitution will continue, albeit at a reduced pace. The conservation and fuel substitution measures taken prior to 1985 are unlikely to be reversed. Also, most consuming countries are not expected to pass through the entire decline in oil prices to final consumers. In the transportation sector, the increased fuel efficiency of vehicle engines is likely to continue, although overall gasoline demand is expected to grow as a result of increased economic activity.

Competition at the bottom of the barrel will influence the consumption outlook, since the demand for fuel oil will depend on the degree of interfuel substitution in power generation and industrial installations, especially in developing countries where oil is the swing fuel. If fuel oil prices rise appreciably above the long-run marginal cost of coal, coal substitution for fuel oil becomes an economically viable option, which, under certain market conditions, can put downward pressure on oil prices. If fuel oil prices fall below this marginal cost, coal loses its competitiveness and the demand for oil increases.

Although the total share of petroleum will continue to decline in LDCs, the absolute level of demand for petroleum in these countries is expected to grow at almost 2% a year, reaching approximately 1.2 billion tons in the year 2000, up from about 750 million tons in 1985. This represents an increase of about 1 million barrels a day (1 MMBD) for the non-OPEC developing countries between now and 1990.

Supply-Side Effects

On the supply side, the world surplus of oil is expected to continue. However, the larger developing countries which have hydrocarbon potential are unlikely to abandon their policies of developing their hydrocarbon resources in favor of imports in order to replace and add to reserves. Nevertheless, it is likely that these countries will find it more difficult to mobilize the financial resources from the international oil industry or the financial community. Resources from the oil industry are unlikely to be forthcoming because of the poor outlook for oil prices, and borrowing from the financial community may be precluded by the debt situation in these countries.

The broader question of financing energy development becomes even more complicated when the total energy sector is taken into account. Countries will need large sums of investment to develop enough supplies to meet even the modest growth in demand projected. These investments can be as much as 4-5% of GDP and well over 25% of public sector investment in most countries. The percentage can be higher for countries in which energy demand is growing rapidly, large scale projects are being undertaken, or infrastructure is needed to support new energy development. 1/

Most of the investments in oil and gas will take place in the middle income oil-exporting countries, and a large proportion of the investment required in both oil importing and exporting developing countries will be for internal demand rather than for foreign-exchange generating exports.

The uncertainty of prices over the foreseeable future will affect decisions about which fuels to use and make access to external resources increasingly difficult. In this climate, market mechanisms will come to play a more important role, as it appears likely that developing countries will find it difficult to continue financing energy development under the traditional public-dominated structure of the energy sector. Changes must be made to provide more flexibility for short term adjustments and opportunities for innovative resource mobilization.

1/ The World Bank has estimated that approximately \$90 billion a year (1982 prices) would be needed in the energy sector over the next decade, including some \$55 billion in the power sector and about \$35 billion for exploration and production in the oil and gas industry. Most of the investment in the latter involves a heavy proportion of foreign exchange, which could amount to about \$30 billion a year during this timeframe, with the refinery subsector included. These figures should be considered very rough estimates since they could vary considerably with changes in the projected supply/demand and pricing scenarios. These changes, in turn, could influence the demand for indigenous supplies.

Energy Investment Policy Issues

Despite these constraints, a large proportion of energy investment will continue to be publicly financed and managed, since any major adjustment process such as this one requires time. However, an increasing share of future investments is likely to be transferred to other forms of ownership and operations. To effectively manage this process, developing countries will have to decide:

- ° what balance is desired between traditional public ownership and other forms of ownership;
- ° how to attract investors to finance non-public ownership; and
- ° how to mobilize domestic and foreign exchange resources for the public sector program.

These discussions will require that the developing countries have a clear strategy for the volume, timing, and form of investments required. The countries will also need a clear set of policies to implement that strategy and enough flexibility in planning in order to consider alternatives.

The formulation of an overall energy sector strategy has been made more complex by the uncertainty over future oil prices and relative fuel costs. These factors have considerably increased the risks associated with planning in the power and industrial sectors. Nonetheless, decision makers need to design strategies that position the country to capitalize on the lower oil prices, while providing the flexibility to switch to alternative fuels if prices increase again. For countries where the sector is dominated by large, inflexible public institutions, considerable adjustments will be required to allow new marketing structures to emerge, to improve or privatize key energy institutions, and to initiate new methods of financing.

In developing these new policies, energy pricing will be an important tool. Countries will need to shift their pricing structures from a centrally planned to a market-based system, particularly if private resources are to be mobilized to finance investment programs. For example, private investment in the power sector could occur if the electricity were sold to the grid at competitive prices; likewise, investments in refineries, LPG, and natural gas facilities could prove attractive if companies were allowed to market the gas or petroleum products in a domestically competitive market.

An important part of developing strategy in many countries will be assessing their overall energy situation and, more particularly, their resource base and potential markets.

As mentioned before, developing countries must carefully consider whether they can afford to incur greater public sector debt burdens by borrowing to continue or accelerate exploration efforts. Furthermore, the capital resources from private oil companies will be scarcer and spent more selectively. In this environment, exploration promotions should continue, but

be well presented and competitive. Similarly, reconnaissance work in the form of geophysical and geological surveys should continue to take advantage of the prevailing low prices for drilling equipment and services and the willingness of contractors to enter into deals for prospective surveys.

After taking stock of their resource base, countries will need to do a thorough assessment of their energy markets. Using revised forecasts for economic growth prospects, a sector-by-sector demand outlook should be developed. This forecast can then be sensitized to various pricing scenarios to determine the probable extent of interfuel substitution. Not only should the substitution of coal for fuel oil be considered, but also the possibilities of developing indigenous gas supplies to substitute for other fuels. This demand assessment will allow countries to better define the decisions and the investments required in both the upstream (exploration and production) and downstream sectors.

A policy on energy pricing is probably the keystone to establishing the framework from which the energy sector can operate. Some oil importing countries may maintain artificially high domestic energy prices as a means for the government to earn revenue and reduce their budget deficits and foreign debts. Artificial pricing should not, however, be allowed to result in energy investment decisions that are not economically viable. Furthermore, while lower oil prices will stimulate the economy, artificially high energy prices will have a detrimental effect on those industries that compete internationally with companies which face lower energy costs.

As part of their strategy, countries will have to weigh the impact of lower oil prices on their past investments and develop criteria for new ones. For example, countries that have invested heavily in domestic energy resources (geothermal, gasohol, coal) to displace imported oil, may now encounter political and socioeconomic resistance to abandoning these investments. To protect these industries before an upturn in world oil prices, countries may opt to impose tariffs on the fuels with which these projects must compete. It is doubtful whether countries should adopt strategies that would artificially insulate new projects from competitive market prices or which would subsidize the projects.

Investment decisions for new energy projects will depend, to a large extent, on whether or not the government perceives that the prevailing low oil prices are a temporary phenomenon and at what level they believe crude oil prices will stabilize in the long term. In reappraising projects, decision makers will certainly need to delay some.

The perceived direction of the government's energy pricing policies also will affect the success of attracting capital for energy investments. Except under special circumstances, it usually is economically prudent for countries to gradually shift from government-fixed prices to prices that reflect market forces and are flexible enough to adjust to changes. In fact, countries that have adopted competitive pricing policies in the past have traditionally experienced sustainable rates of economic growth.

With a clear and realistic set of pricing policies, countries will be in a better position to mobilize domestic and foreign sources of capital for energy investments. To accomplish this, developing countries should be flexible in considering new and innovative approaches to energy sector structuring and the financing of energy projects. Non-recourse or limited recourse financing should be seriously considered so that the financing choice is not reflected in the country's credit or debt situation. Petroleum development projects, which involve high capital outlays but also high rates of return, are good targets for this type of financing because the cash flow from the project can cover the debt service and should provide reasonable profits. There are two required conditions for limited recourse or project financing. One is an acceptable perception of country and project risk. The other is a strong, internationally recognized partner. An export orientation is preferable so the project can generate foreign exchange. These conditions may not prevail for a large number of projects, particularly those involving import substitution. Nevertheless, a special effort should be made to explore this possibility, if only because the benefits of a thorough risk analysis would establish the viability of the proposed investment.

The well-known practice of leasing plants and equipment can be applied to the energy sector as a means of raising cash. For example, a utility could sell its existing plant to private investors to operate and buy back the power at rates which would provide an acceptable and immediate return on their investment. The utility could use the funds for other purposes while maintaining use of the assets. There are also applications of this leasing principal in the petroleum sector, i.e., leasing rather than purchasing certain oil field equipment.

The custom of issuing tax-exempt and revenue bonds is widespread in the developed countries but could be more fully utilized by power companies and certain petroleum ventures in developing countries. These bonds can be particularly helpful in financing the local investment costs of a project where foreign exchange is not a consideration. Presenting investors a practically guaranteed albeit low return on their investment and a cushion against devaluation due to local inflation would attract local sources of funds and might stem the exodus of capital from the country.

As part of their strategy, developing countries should enter into joint venture arrangements to lower their budgetary requirements and allow the international oil companies to spread out their investment capital. Payback arrangements for both the private and public sector partners can be flexible so as to accommodate them both.

In addition to the measures described above, developing countries must increase energy sector institutional efficiencies to attract private capital. This generally involves the privatizing of state-owned companies--a practice which is especially important now that these companies have less of a cushion from the large profits associated with high energy prices. The problem of inefficiencies can be found in all sectors, and privatization strategies may vary from country to country depending on the political climate, the level of development, and the overall objectives of the government. Nonetheless, privatization is most urgent in the energy sector since it

is larger than most others, requires a higher proportion of total government investment, and has a trickle down effect throughout the economy.

The process of privatizing national oil companies will require a reevaluation of general macroeconomic policies as well as an examination of ways to restructure the industry, introduce more market forces, revise regulations, and improve managerial skills. In addition, legal and institutional arrangements should be revised in order to broaden the scope for private sector involvement. Privatization could also involve identifying investors, selling stock on the market, and developing principles for compensating private investors (via dividends, etc.). Increased efficiencies, access to privately held technologies, and enhanced opportunities for growth can compensate for any temporary dislocation (i.e., workers' transfers, etc.) or loss of economies of scale.

Regardless of a country's ideological views on public ownership, the long term goal should be a gradual shift to private ownership throughout the subsectors of the energy industry. Where it is not feasible to introduce market forces or attract private investment in the sector, efforts should be made to maintain and strive for more efficient and cost sensitive operations. These new financing techniques and the restructuring and privatization of the energy industries have applications in both the upstream (exploration and production) and downstream activities.

Upstream Investment

There are several traditional sources of financing for exploration activities. These include: equity from international oil companies, budget expenditures by national governments, and retained earnings. Over the past decade, there has been growing public sector financing of projects in a number of developing countries such as India, Brazil, and Argentina. Over the past few years, with prices declining and industries being restructured, terms have become more liberal, reflecting this more competitive environment.

The developing countries, as well as the international oil companies, will continue to explore for oil, but the latter will be more selective about the geology, contract terms, and the conditions (i.e., political climate) associated with the project. To react, developing countries will have to introduce more attractive terms, such as reducing government take and introducing more flexibility in the contracts. Thus, contract renegotiation to reflect changing market conditions will become common. Therefore, contracts should better define this framework and look at a range of options including: (a) seismic surveys; (b) joint ventures; (c) risk sharing farm-out; (d) farm-in producing areas and exploration; (e) access to domestic downstream markets (particularly for natural gas); and (f) longer exploration periods.

A number of countries with petroleum capabilities of their own will continue their exploration programs to replenish reserves and discover new plays. Efficiency becomes more important in an environment of lower prices

and scarcer capital in order to reduce costs. Countries should also look into the possibilities for risk diversification, including the introduction of new buyers (domestic and foreign) and investing outside their own territory.

For a large number of producing countries with high potential, exploration based on their "national capability" is a necessity, since they need to replenish reserves and assess their potential as an input to their economic planning. The main problem is the structure of this "national capability." It does not necessarily have to be 100% publicly owned; rather, a domestic private sector can be developed, as in Argentina. The potential for this type of private industry exists, for example, in India, Pakistan, Brazil, Colombia, and Peru. This type of structure also could provide new sources of risk capital.

Developing proven hydrocarbon commercial reserves is not particularly difficult, especially if part of the production can be exported. This process is expected to continue; however, there may be limitations because of lower economic thresholds which may delay projects and inadequate terms which prevent operators from mobilizing financing. These questions are likely to be addressed in case-by-case negotiations. Contract terms and tax regimes introduced a few years ago are no longer likely to prove attractive, and a flexible attitude on the part of state oil companies will be required to avert a rash of relinquishments, particularly in the marginal areas.

One main issue is the development of hydrocarbons for domestic markets (particularly natural gas) which would not generate foreign exchange to cover debt and operator profits. If a country is credit worthy, sovereign risk borrowing is possible. In many cases, borrowing capacity may be a problem and alternative approaches need to be considered, such as structuring the project on the basis of non- or limited-recourse financing. Most important is finding ways to secure foreign exchange, for example, through swaps in which payments for gas are made in petroleum products or crude oil, or through the export of natural gas liquids or countertrade. In fact, equity participation in downstream facilities (particularly for gas) should be encouraged. Countries also can seek financial guarantees from commercial or multilateral institutions. They can look outside the energy sector to enclave projects where hydrocarbons are an input to the manufacturing of an exportable product, such as methanol, urea/fertilizers or power.

Developing countries are considering a number of these alternatives, and a few deals already have been concluded. The main issues are: identifying investment opportunities around which to structure the project; reconciling the interests of the various partners through an orderly process of negotiations based on a thorough risk analysis; and finding adequate arrangements for risk sharing.

Downstream Investments

Renewed economic growth will mean increased energy consumption. There is still an enormous gap between the LDCs and the developed countries in

terms of levels of energy consumption. During the 1970s, developing countries gave priority to resource development; now downstream activities are emphasized. The goals are to obtain a better fuel mix, eliminate refinery inefficiencies, and realize a higher product value, for example, through the extraction of LPG. The diversification of supply is a goal of all countries, especially as the OPEC proportion is expected to increase. Countries also seek capacity adjacent to their natural market, and they can invest in refineries in such regions. They are also concerned about optimizing the production of refined products domestically in order to minimize foreign exchange costs (and loss of value added) associated with imports. Nonetheless, for those countries which have low demand for fuel and little potential market growth, the alternative of importing refined products may be more economic.

Most importantly, developing countries are concerned with maintaining flexibility during a time of uncertain oil prices and shifts in relative fuel costs. Large investments are required in the downstream areas of refining, gas treatment and transmission, oil products, LPG, and gas distribution. While the risk of making a mistake is greater in this environment, the costs of making a wrong decision are also higher.

The market will require considerable work to identify real opportunities; therefore, countries will need to move from an allocative market system to a market-based system. As noted above, this requires a competitive pricing system based on market forces and a thorough market assessment and the design and implementation of a marketing strategy.

The developing countries are weak in these areas and will require expertise in much of the work to be done. The provision of expertise is essential in order for developing countries to implement their energy strategies and attract private capital; in this regard the World Bank can be of assistance.

The World Bank Role

The World Bank has been active in the energy sector of developing countries for some time. Between 1975 and 1980, the Bank committed more than \$10 billion for energy development, including funds for electric power, oil and gas exploration and development, as well as infrastructure, refineries, pipelines, etc. The Bank has helped countries perform assessments of their resource and supply and demand situations and has helped them to promote exploration projects, particularly when no exploration had previously taken place. Together these projects have enabled developing countries to develop their resource data base and begin to formulate comprehensive energy strategies.

To stretch out the energy funds it has available for lending, the World Bank is promoting joint ventures; under these arrangements the Bank finances the foreign exchange portion of the developing country's share of the project costs. The Bank's funding for oil and gas projects, which should

reach roughly \$700 million in 1987 and \$1.2 billion in 1988, will have a positive impact on the capital available to the developing countries, when coupled with the resources that can be mobilized from the private sector.

Almost three-fourths of the funding for oil and gas projects will be dedicated to natural gas projects. Investors are carefully reviewing their technical design and financial returns because of competition from cheaper fuel oil. However, the short-haul projects may still prove economic if the gas can be used domestically to free up oil for export, replace dwindling reserves, or substitute for fuel imports. However, few countries have the necessary funds or the institutions and technical skills to effectively manage this resource. Under these circumstances, countries are calling upon the Bank to play a greater role. The Bank firmly believes these projects should play a key role in the countries' overall energy strategies.

As another way to encourage the flow of investments to developing countries, including projects in the energy sector, the World Bank has created a new agency, the Multilateral Investment Guarantee Agency (MIGA). When it becomes operational, MIGA will provide, for a fee or premium, guarantees against four categories of non-commercial risks:

- ° host government's restrictions on conversion and transfer of foreign exchange;
- ° losses resulting from legislative action or administrative action by the host government;
- ° the repudiation of a contract by the host government; and
- ° war and civil disturbance risk.

Conclusion

To prepare for the hardening of oil prices in the future, developing countries need to adopt robust energy investment programs to expand domestic energy supplies and restructure the sector, where required. Oil-exporting developing countries must decide how to maintain growth in the face of falling export revenues and how to restructure their oil industries to be better able to cope with the new, market-oriented, international industry. Oil-importing developing countries have to decide who should be the beneficiary of the lower prices and plan their fiscal policies and energy programs to take advantage of the opportunities offered by the new pricing outlook while minimizing their longer-term risks.

Energy-related investment requirements in developing countries will remain high, requiring large amounts of financial resources to be mobilized under conditions of resource scarcity and high debt burdens in the developing countries. These countries will have to adopt policies that attract private capital in an investment climate that is nervous about the impact of uncertain oil prices.

Since both major international oil companies and financial markets will greatly restrict their discretionary outlays and loans for exploration and development, even in countries which have relatively good prospects, there will be a trend towards more selective exploration programs. In short, there are more opportunities worldwide than there is capital available to develop them. LDCs that have exploration and/or development potential will have to adjust to the new investment climate by increasing their knowledge of their resource base, making more attractive areas available, modifying existing contract arrangements, and negotiating more flexible contracts. With realistic government policies and an open, flexible attitude toward private sector involvement, exploration and production activities should continue.

Countries should develop strategies that call for initiatives to privatize their energy sector in order to improve efficiency, attract private investors, and minimize government debt burden. They should encourage increased competition in the market place, including less direct government control, and a decentralization and divestiture of services that could be provided by a competitive private sector. Companies should be allowed access to domestic markets for sales of natural gas and petroleum products in order to encourage investment in both upstream activities and refineries, LPG plants, and pipelines.

Despite uncertainties over the position of relative fuel costs in the future, investment decisions in power generation and heavy industry cannot be postponed indefinitely. Instead, they should be influenced by the need to have greater fuel switching capacity in order to maintain flexibility to respond to any future price fluctuations. Likewise, natural gas projects which can displace fuel imports or free up oil for export should go forward.

During this period of increasingly difficult access to financial resources, developing countries will need to implement policies that call for a thorough reassessment of their supply and demand situation, strike a better balance between public and private sector involvement, and promote increased efficiencies and competitiveness in the energy sector. They will need to adopt realistic pricing strategies and demonstrate flexibility in order to mobilize resources.

Role of the World Bank in Gas Development

Eugene D. McCarthy

The uncertainty brought about by the recent sharp decline in oil prices generates risks for future investors and makes the task for policymakers in developing countries particularly complex. The risks for investors go in both directions. On the one hand, there is the risk of being unduly cautious and not taking advantage of the prevailing lower oil prices to prepare for a likely return of higher oil prices in the 1990s. On the other hand, there is the risk of being too adventurous, overcommitting to large, capital-intensive projects that may be vulnerable to changes in future oil prices. The dilemma is how to plan and invest in such a climate of uncertainty. This paper attempts to highlight some of the important policy, institutional, and technology transfer objectives that should be pursued in developing energy resources during this period of uncertainty. Special emphasis is given to the development of natural gas resources in the developing world where the World Bank has been very active.

Before discussing the issues involved in natural gas development and the involvement of the World Bank in certain gas-related investments, it is important to understand first, the World Bank and its modus operandi, and second, the impact of reduced oil prices for investment in developing countries.

The World Bank Group

The World Bank Group comprises the International Bank for Reconstruction and Development (IBRD) and its affiliates, the International Development Association (IDA) and the International Finance Corporation (IFC). The common and general objective of these institutions is to help raise the standards of living in developing countries by channeling financial resources and policy/technical advice from developed countries to the developing world.

The IBRD, established in 1945, is currently owned by the governments of 149 countries. The IBRD, whose capital is subscribed by its member countries, finances its lending operations primarily from its own borrowings in the world capital markets. Part of the IBRD's resources also comes from its retained earnings and the flow of repayments on its loans. IBRD loans generally have a grace period of three to five years and are repayable over fifteen to twenty years. They are directed toward developing countries at

Note: The initial draft of this paper was presented at the Asia-Pacific Gas Technology Conference held in Kuala Lumpur, Malaysia, in September 1986.

more advanced stages of economic and social growth. The interest rate the IBRD charges on its loans is calculated in accordance with a guideline related to its cost of borrowing, and it is held close to the LIBOR rate charged by commercial banks. The current rate for the first half of 1986 is 8.5%.

IDA was established in 1960 to provide assistance for the same purposes as the IBRD, but primarily in the poorer developing countries and on terms that would bear less heavily on their balance of payments than IBRD loans. IDA's assistance, therefore, is concentrated on the very poor countries--those with an annual per capita gross national product of less than \$790 (in 1983 dollars), although 90% of the IDA money goes to countries with less than \$400 per capita. More than fifty countries are currently eligible under this criterion.

Country eligibility for IDA assistance is determined by the following three criteria:

- ° poverty (as measured by per capita income);
- ° limited creditworthiness for borrowing from conventional sources; and
- ° economic performance, which includes an ability to make effective use of resources and the availability of suitable, economically-viable projects.

The IFC was established in 1956. Its function is to assist the economic development of less-developed countries by promoting growth in the private sector of their economies and helping to mobilize domestic and foreign capital for this purpose.

The assistance, both financial and non-financial, given to LDCs by these three institutions is designed to directly affect the well-being of the masses of poor people in developing countries by making them more productive and by integrating them as active partners in the development process. In the last five years, the Bank as a whole has stepped up its lending for energy development, which includes exploration and development of petroleum resources. Although lending for power forms the largest part of the Bank's energy program commitments, oil and gas development have shown the greatest increase.

It is important to note that the transfer of resources to developing countries is only one--albeit the most visible--aspect of the Bank's developmental role. Its role as a partner in the dialogue with governments on overall economic policy and sectoral strategies, and as a source of technical assistance and advice, is as important as its role as a lender. The deteriorating economic climate in many of the Bank's member developing countries has increased the importance, as well as the visibility, of this advisory function.

Oil Price Impact

The precipitous decline in international crude oil prices in recent months is an important development comparable in reverse to the two upward price shocks of 1973 and 1979. The effects of these developments are still in process. How one views them depends very much on where one stands. The oil price collapse has had an impact in three major areas: (a) on the world economy; (b) on the petroleum industry itself; and (c) on energy policies in the developing countries.

In viewing the effects on the world economy, a distinction must be made between direct and secondary effects, and between immediate and longer term results. OECD countries have been major beneficiaries of the income transfer (due to reduced oil import costs), with Japan, West Germany, France, and Italy receiving about 40% of the total. Many developing countries will also benefit from such direct import savings--Turkey, Thailand, Korea, Brazil, and India being principal cases. Countries in this group might expect to save between 10% and 20% (or more) of their total import bill.

In contrast, serious export revenue losses are being felt by the North Sea countries, the Soviet Union, and a number of other developing countries of which, in East Asia, Indonesia and China are notable. There are, however, secondary effects of the price decline which benefit all countries, importers and exporters alike. These include: the non-oil trade linkages; the impact on inflation and interest rates, and hence on debt service; and the possible improvements in the terms of trade for many countries as OECD import demand expands and the U.S. dollar depreciates. All these factors benefit the growth prospects in a wide range of countries.

The collapse of oil prices has special implications for energy policy in developing countries. The policy implications are immediate and in some cases--particularly in the exporting countries--serious. It is clear that governments in both importing and exporting countries face important and urgent decisions on how to respond to cheaper petroleum. The need to act is most pressing in the exporting countries where the revenue loss, coupled with a resulting loss of borrowing power, can be accommodated only by sizeable reductions in expenditure. In the oil importing countries, the issues of distributing benefits do not make the policy choices any easier, more obvious or less political in content. Continued expansion of the energy sector is still not cheap. If a decade of lower oil prices provides a major boost to world economic growth, the supply of energy resources in time will need to be expanded. Thus, the energy sector will continue to absorb a large share of the investment programs of the developing countries (between 15% and 35% commonly; in some cases above 50%) and energy pricing, sound management, and due attention to efficiency will be no less important than in the past. One particular challenge will be finding debt minimizing ways to finance the expansion. Improving the efficiency with which capital is used is a critical issue for developing countries.

Regional Energy Policy Issues

Before discussing the World Bank's specific involvement in natural gas, some general observations on the energy issues of the Asian Region are appropriate. The East Asia and Pacific Region comprises a number of developing countries with quite different energy problems without a common theme. In the oil-importing countries such as Thailand, the Philippines, and Korea, there will be a need to maintain policies which encourage efficient use of energy, as well as attract scarce private risk capital to continue exploration. Equally, there will be a need to: (a) carefully review investment options in a climate of uncertain oil prices; (b) examine the scope for restructuring their large national oil companies in the sector; and (c) support the mobilization of domestic resources at a time when government revenues are declining. For a second group of countries which export oil--Indonesia, Malaysia, and China--there will be a short-term need to maintain, as far as possible, export revenue, while in the longer term reduce their potential vulnerability to a single energy choice. Investment strategies in these countries should promote energy diversification, particularly into natural gas, LPG, and, where feasible, domestic coal. Natural gas merits special attention. The awareness of natural gas as an important source of energy is relatively recent in this group of countries; but, at this moment many of these countries (Korea, Indonesia, and Malaysia) are on the verge of developing domestic gas industries.

The realization of the importance of natural gas in a country's energy balance has gone further in Asian developing countries than in other LDCs and has provided an important stimulus for the economic development of several of these countries endowed with commercially exploitable gas reserves. In Pakistan, it already meets 40% of total commercial energy needs. In India and Bangladesh, major projects are under way for the continued development of gas fields and the building of downstream infrastructure for domestic use; Thailand has already successfully completed the first phase of its natural gas development, and there is clearly potential for further development. In China, there is an increasing awareness of the importance of natural gas in its energy balance, heightened by the realization that a major part of its offshore hydrocarbon potential may not, in fact, be oil but natural gas. Indonesia is the largest exporter of LNG, and Malaysia, as mentioned before, is already exporting LNG and is now preparing to undertake major gas investments for domestic use. Even in Burma, greater attention is now being given to natural gas reserves and the potential for increased domestic use. Finally, both Korea and Singapore are preparing themselves for introducing imported natural gas, both as a fuel and feedstock, into their economies.

Natural Gas

Natural gas reserves exist in about 50 developing countries, including at least 30 that presently import oil. In these countries, gas reserves were found in the process of exploring for oil, but they have not

been fully developed or evaluated because of the lack of immediate incentives to invest in their development. In a large number of developing countries, the utilization of natural gas could greatly reduce the dependence on oil imports or allow larger oil exports. However, before natural gas can be developed, there are a number of institutional, contractual, financial, and technical issues which have to be resolved. It is for these reasons that many countries have delayed the development of natural gas resources. With this in mind, about 10 years ago the World Bank began to assist its member countries in the development of natural gas resources, not only by providing financing for specific projects, but by providing a comprehensive program in planning natural gas development from the exploration phase to the market place. In particular, the World Bank assisted countries in evaluating domestic and international markets for natural gas and in addressing key policy issues, including gas pricing, in order to maximize the use of the resource for the benefit of the countries involved. Since each country is unique, before a comprehensive program for developing natural gas can be established, the particular situation within the country, such as the availability of other energy resources, pricing, marketing, the existing infrastructure, must be studied in order to draw up an appropriate gas development strategy.

The fundamental requirements that are common to all the developing countries are: (a) that the natural gas be relatively low cost; (b) that there exist, or can be developed, a market that can compete with other sources of energy; and (c) that there is a capability and opportunity within the country to develop the necessary infrastructure. Gas development is often treated in the same way as oil development, despite clear differences at various phases of implementation. As a result, gas has been flared and/or has remained undeveloped despite marketing opportunities.

Investment Implications of Oil Price Decline

The recent decline in oil prices has investment implications both for energy investments overall and for natural gas in particular.

Changes in oil prices clearly affect the future consumption patterns of all commercial and non-commercial energy sources. In countries with less regulated energy markets, the recent fall in oil prices has been partially or completely passed on to consumers. This has, in some instances, already increased the demand for oil products. In the many developing countries where fuel prices and supplies are more heavily regulated, there has been more of a lag. Although flexibility in fuel switching may be limited in the short run, over the longer run, if oil prices remain below alternative fuel prices, oil consumption will certainly increase.

One result of greater oil price uncertainty is that larger energy consumers will consider investing in more flexible equipment in order to increase fuel switching capacity in the event of any future price fluctuations. This has already begun to happen in many developed countries. The same process of fuel diversification and investment in fuel switching capacity is expected to proceed in many of the middle-income developing countries.

Some of the poorer developing countries, however, cannot afford the higher capital cost of investments that allow for greater fuel flexibility (e.g., dual fired power plants). As a result, they may remain relatively more vulnerable to sudden fluctuations in fuel prices.

Natural gas investments most likely to be affected by lower fuel oil prices are those involving longer distance pipelines and liquefied natural gas, because of the very high up-front fixed costs. Natural gas development for domestic use in countries with lower cost supplies and relatively short distances to the market should, in many instances, remain economically attractive. Also, where gas pipeline networks have already been constructed, as in Bangladesh, Pakistan, Yugoslavia, and Argentina, the incremental cost of additional gas production will likely be lower, or at least no greater, than fuel oil costs. Where gas resources have been discovered but not developed, as in Papua New Guinea, the choice between gas and fuel oil is likely to be more difficult, and will depend, to a large extent, on the potential size of the domestic market and on the relative cost of alternative fuels.

World Bank Involvement in Natural Gas

World Bank lending activities for natural gas have been extensive, particularly in Asian developing countries, where they continue to expand. A few of these natural gas projects are presented below.

Pakistan

The World Bank has had a long-standing involvement in the development of natural gas in Pakistan, starting from the early 1960s. Several lending operations have been made to support gas transmission and distribution systems from the main source of gas supply, the Sui field. Most recently, in 1982, a \$43 million loan from the World Bank helped to finance a \$196.8 million project as part of the Government's plan to increase gas production by 30 million cubic feet per day. The project was designed to further expand the Sui Northern pipeline system, the largest in the country, to transmit and distribute an additional 70 million cubic feet of gas daily. Project components included the installation of a gas purification plant to treat additional raw gas, construction of about 430 miles of high pressure transmission pipeline, and installation of 5 turbine compressor units in 4 existing compressor stations. In addition, the project will provide a service line for some 25,000 new connections to the system each year between 1984 and 1986.

The Government of Pakistan had been setting consumer gas prices below the true economic value of this resource in order to foster greater use of gas. These prices have stimulated demand but they have also discouraged gas exploration and development. As a result, progressively severe shortages have arisen since 1978 which curtailed economic growth by impeding power generation and industrial production. As a result of these policies, the oil companies have been slow to develop existing small fields and potential new reserves, which has resulted in an overall shortage of gas. Over a dozen

prominent structures in gas prone areas still remain to be tested and some discoveries have yet to be evaluated. Bank involvement has helped bring to the Government's attention the basic need for a new gas producer pricing formula if natural gas is to be developed. The Government recently enacted such a pricing formula which, it is hoped, will increase the willingness of private companies to develop new fields. Presently, new entrants as well as existing concessionaries are discussing gas prices with the Government of Pakistan. In 1985, the World Bank approved a loan of \$55 million to support the further expansion and appraisal of oil and natural gas reserves in Pakistan involving the Government of Pakistan and two successful private companies.

Thailand

The World Bank has been involved in natural gas development in Thailand since 1979. In that year, the World Bank provided a \$4.9 million loan to help finance the initial engineering phase for developing Thailand's natural gas potential, which comprised preparatory work for constructing the gas pipeline by 1981. This was followed in 1980 by a \$107 million loan which was designed to support a project to construct a pipeline system to transport gas from the Union Oil offshore and to distribute it to industrial consumers--chiefly power generating stations. In addition, the technical assistance component provided training of the Petroleum Authority of Thailand (PTT) staff in administration, operation and maintenance of the natural gas pipeline and distribution system, and advisory services in finance and technical assistance for the refinery expansion study and an energy conservation study. As a follow-up to the gas pipeline project, the World Bank in 1982 financed a gas complex by providing a \$90 million loan to PTT. This plant is fed by natural gas from the previously financed natural gas pipeline. Furthermore, since that time, the Bank has continued a dialogue with the Government of Thailand, PTT, and Shell. Very recently, the Bank also helped finance PTT's share in the exploration and development of the Sirikit oil field. Of equal importance to its financing role has been the collaborative non-financial role the Bank has played in supporting the formulation of a long-term energy investment plan. This effort culminated in the symposium held at Pattaya at the end of last year. This support continues during the implementation of this plan.

India

In India, the Bank participated financially in four offshore petroleum projects. Two of these loans were for the development of the Bombay High oil field located off the west coast of India. A third Bank loan of US\$165.5 million was made to India in 1982 for offshore petroleum operations. This loan is being used to finance exploration/appraisal activities in selected areas of the offshore and onshore Krishna Godavari Basin. A fourth Bank loan made to India, also for an offshore petroleum project, was to develop the field and included the construction and installation of process and well platforms, drilling of production wells, undersea gas pipeline to Hazira in Gujarat, and gas treating facilities onshore. The project is being implemented and is scheduled for completion in 1987. This development marked the first significant supply of gas for the fertilizer industry and power markets and is a major step towards developing a domestic gas industry in

India. A second phase development is currently under preparation to provide gas supplies for the major 1,800 km onshore gas pipeline, the construction of which will start in the near future.

Bangladesh

At the request of the Government of Bangladesh, the Bank affiliate, IDA, recently approved a \$70 million loan to finance part of the cost of a gas development project. The main purpose of the loan was to rationalize gas development and provide adequate supplies to the Dhaka area over the medium term. (An earlier project investment of approximately \$110 million in 1981 helped to finance a major gas development and transmission system to Chittagong from Bakhrabad gas field.) The recently approved project has two main components: a gas field appraisal and development program, and a gas infrastructure component. The development component involves the Kailashtila and Beani Bazar gas fields located in the northeastern part of the country. These fields yield gas relatively rich in condensate which adds to the attraction of the field development. The gas infrastructure component includes the design and installation of surface facilities at Kailashtila, Beani Bazar, and Rashidpur and a 117-mile pipeline from Kailashtila to the main gas grid. One of the major components of Bank technical assistance to Bangladesh was to focus on establishing an equitable and rational natural gas pricing policy. In the past, low prices for natural gas have been partly responsible for encouraging rapid growth in demand and the inefficient use of gas. The level and structure of gas prices have been determined largely by administrative regulations. Prices therefore did not reflect the economic cost of different consumer groups and were not designed to allocate natural gas efficiently. Until World Bank involvement, there had been no attempt to study gas prices systematically. As a result of Bank involvement in this project, the Government of Bangladesh recognized the importance of instituting a more rational gas pricing system and has begun to act to promote the efficient use of natural gas while recognizing economic, financial, political, and social constraints. Pricing studies for the use of gas by various industries are currently being conducted in Bangladesh based on the ideas and suggestions of the World Bank.

China

The World Bank has become more involved in the Chinese petroleum sector over the last five years, most recently in the Sichuan Province, where it helped finance a technical assistance project to assess the potential for recovering additional gas reserves from the Weiyuan gas field. Natural gas will play a growing role in China's energy balance over the next two decades; its importance has been heightened by the large natural gas discovery in the South China Sea which followed the first round of exploration activities. Developing the full benefits of the country's natural gas potential, both onshore and offshore, is critically important for China's economic growth. The World Bank has initiated discussions and seminars with Chinese authorities on the importance of natural gas to the country; on the need to develop capable institutions dedicated to the transmission, distribution, and marketing of this energy resource; and on the need for coordination with the eventual users of the gas, particularly in the fertilizer, industry, and power

sectors, as well as in town gas use. These conversations, both in regard to onshore and offshore gas prospects, are continuing with the Chinese authorities.

The foregoing provides some examples of the Bank's involvement in natural gas development in Asia. The Bank also has worked in Africa, Latin America, the Middle East, and North Africa. In fiscal year 1985, the Bank committed about \$850 million to finance oil and gas projects in 14 developing countries. Of this amount, over half (\$525 million) was used directly for gas development.

Conclusion

In the future, developing countries will need to continue investing in the energy sector and in the gas subsector particularly because natural gas has the potential to satisfy diverse energy needs and alleviate the burden of oil imports. Each investment will have to be carefully scrutinized, however, in the context of current and future oil price movements, the supply cost of alternative fuels, and the scope for attracting private entrepreneurs to help provide some of the needed investment. As has been the case so far, World Bank financing will continue to play a catalytic role in attracting other investors and lenders to participate in high priority, economically sound, and financially attractive projects in the natural gas subsector. Developing natural gas potential will be a major step forward for developing countries in diversifying future energy supplies, reducing their vulnerability to oil price increases, and enhancing economic growth prospects.

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